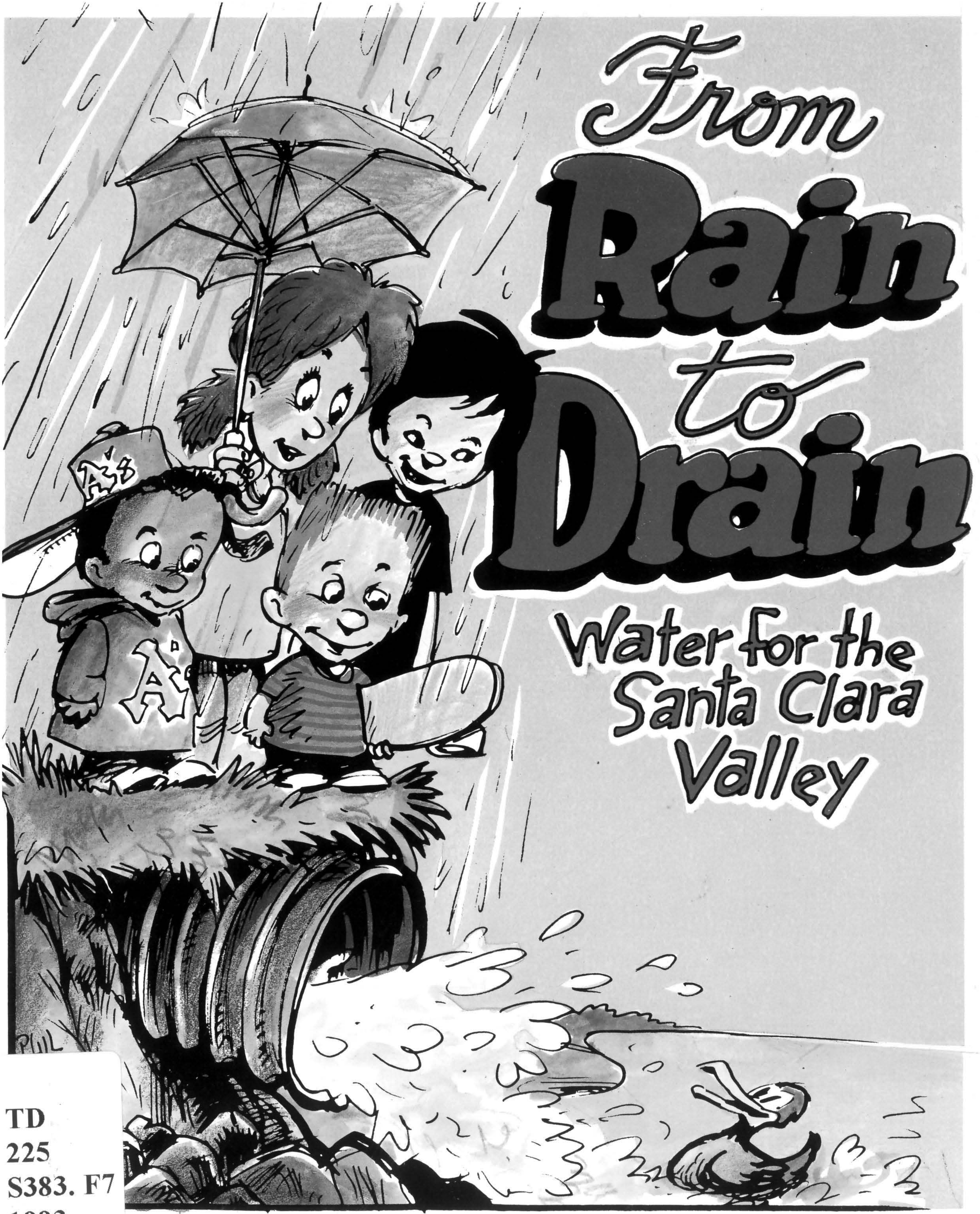
From Rain to Drain

Water for the Santa Clara Valley



Presented by The Santa Clara Valley Water District and
e Santa Clara Valley Nonpoint Source Pollution Control Program

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Sources Of Our Water

On the previous page, we talked about how water makes a continuous cycle from sky to land and back. For all of us, the most important part of that cycle is when the water is on earth.

But even after water lands on our planet, a lot has to happen before it comes out of someone's faucet. The Santa Clara Valley Water District and many other agencies work together to make sure there is always water flowing in the underground pipelines. These pipes carry water to the people of the Santa Clara Valley. Homes, farms, businesses and many others depend on this water coming out of their faucets whenever they need it.

Long before the first pioneers, people found the Santa Clara Valley was a wonderful place to live. The first inhabitants were native American Indians. They got plenty of water from streams. Later farmers and settlers used water from these same streams for their crops.

They built dams on streams to make lakes for storing water and preventing floods. We still build lakes for storing water. They are known as **RESERVOIRS**.

Today, more than 1.5 million people live in Santa Clara County. We all need water for washing, cooking, drinking, growing crops and making products. We also use it in sinks and toilets to carry wastes away.

In fact, people today need far more water than local rains provide. That's why more than half of Santa Clara County's water is **IMPORTED**, which means it is brought in from other parts of California.

Some of our imported water comes from streams far north of us. It flows into Lake Shasta, a very large reservoir on the upper Sacramento River. Water from Lake Shasta flows down the Sacramento River. After passing the city of Sacramento, the water flows into the Sacramento-San Joaquin **DELTA**. This is an area made up of many square miles of flat and very fertile farmland where the waters of these two great rivers meet and join San Francisco Bay.

Deltas are found in many parts of the world. They are flat, wet places where water moves slowly. And our delta is no exception. California uses its delta as a kind of water warehouse, and pumps water from it to the dry farmlands of the Central Valley and to the thirsty residents of many parts of the state, including Santa Clara Valley and Southern California. Two large canals (the Delta-Mendota Canal and the California Aqueduct) and a giant system of pumps carry water south.

Some water from each of these channels flows into the San Luis Reservoir, just a few miles from our valley. By this time, the water has traveled hundreds of miles from its starting point in the far northern part of the state.

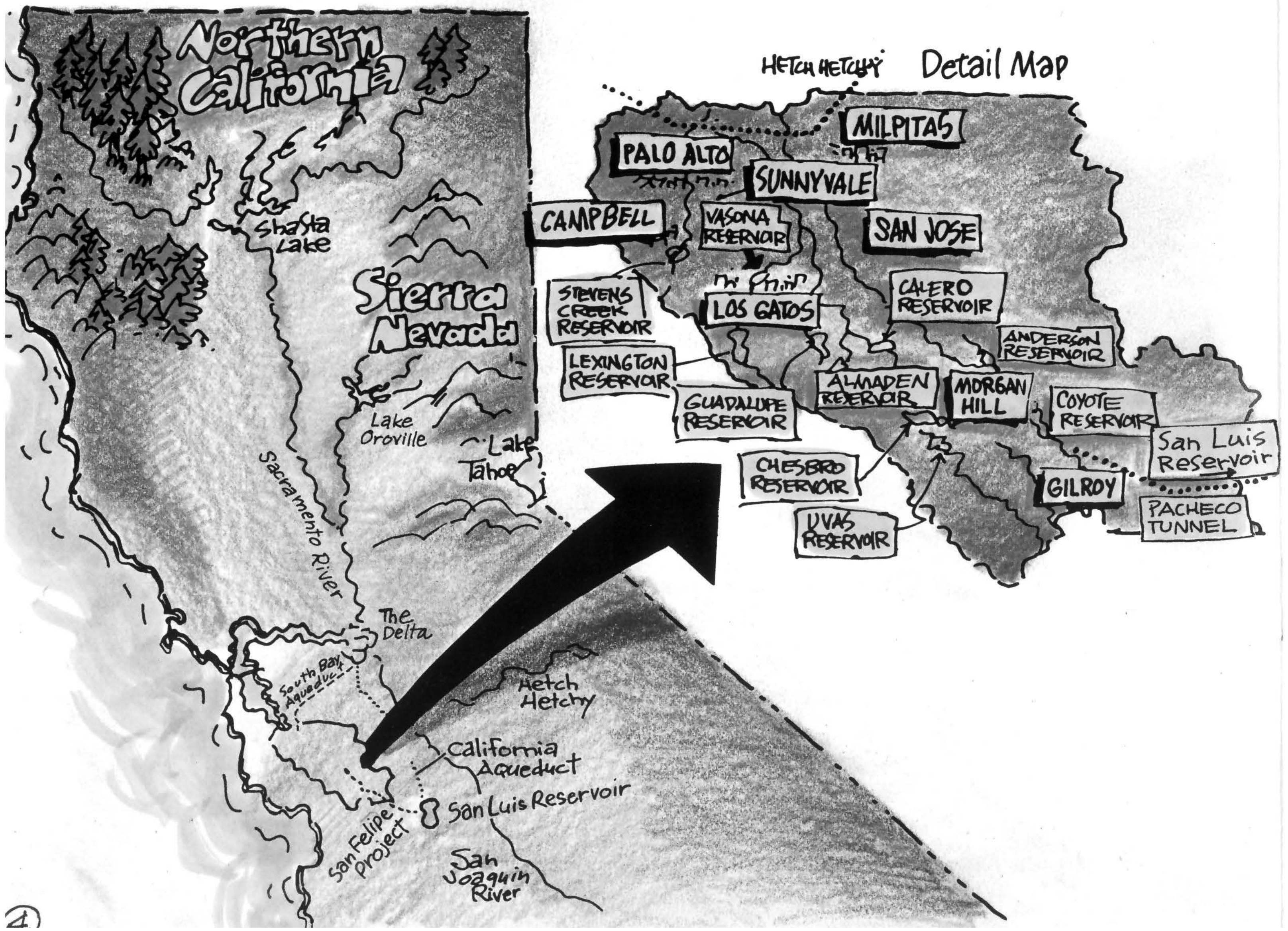
More imported water comes from Lake Oroville. From there it flows down the Sacramento River and into the delta. It is pumped into the California Aqueduct, then into the South Bay Aqueduct, which ends near Milpitas.

Water from Lake Shasta is part of the federal government's Central Valley Project. Water from Lake Oroville is part of California's State Water Project.

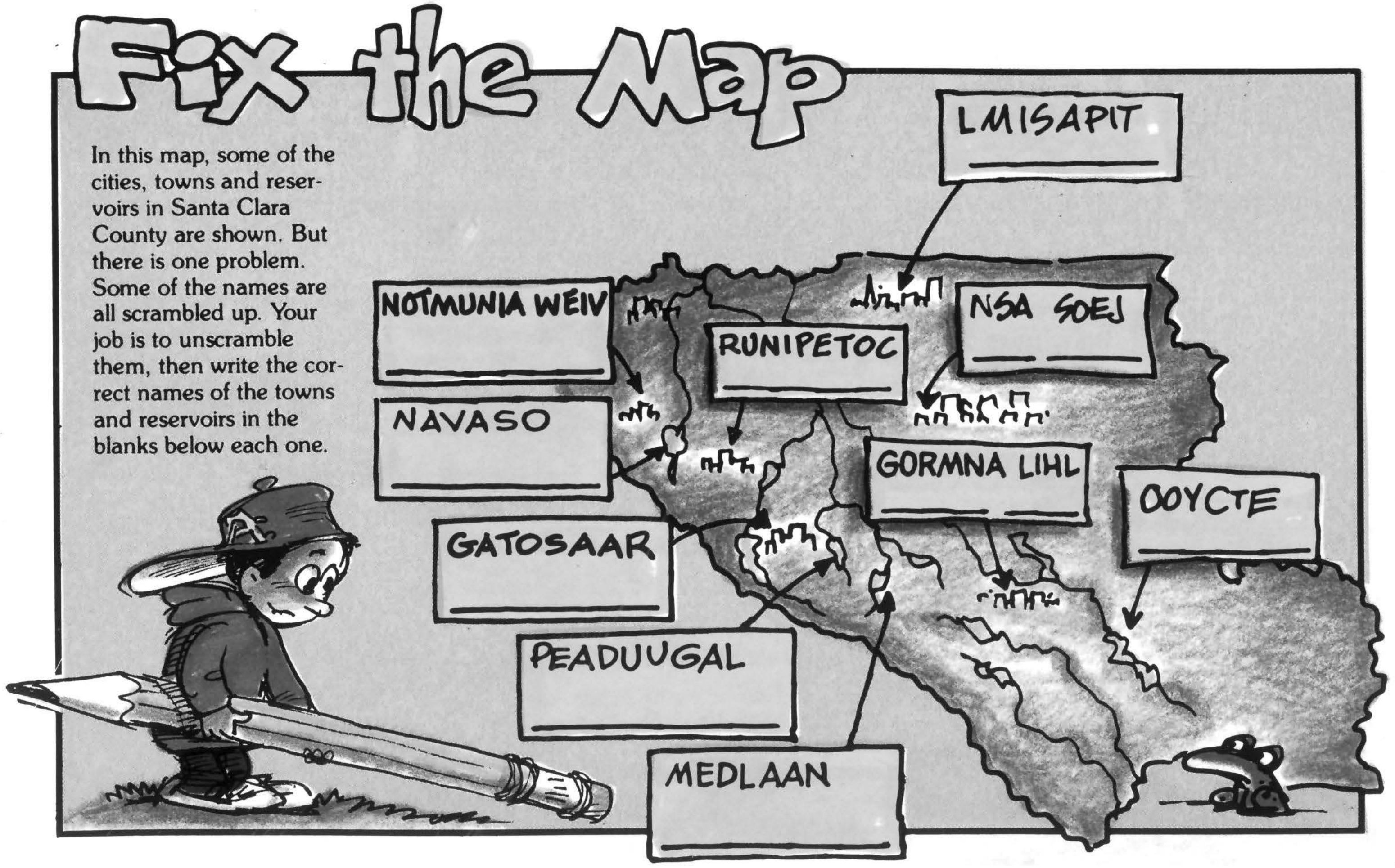
Still another source of water for the Santa Clara Valley is the Hetch Hetchy Aqueduct. This is a large pipeline owned by the City of San Francisco which brings water from the mountains near Yosemite National Park.

The three sources of imported water — Lake Shasta, Lake Oroville and Hetch Hetchy — supply about half of our water in non-drought years. The other half comes from winter rain, captured in local reservoirs. Later, water from the reservoirs seeps down into the ground.

The 10 reservoirs in our valley that capture water which seeps into the ground are: Almaden, Anderson, Calero, Chesbro, Coyote, Guadalupe, Lexington, Stevens Creek, Uvas and Vasona. They are shown on the map on page 4, along with some of the cities and towns in Santa Clara County.

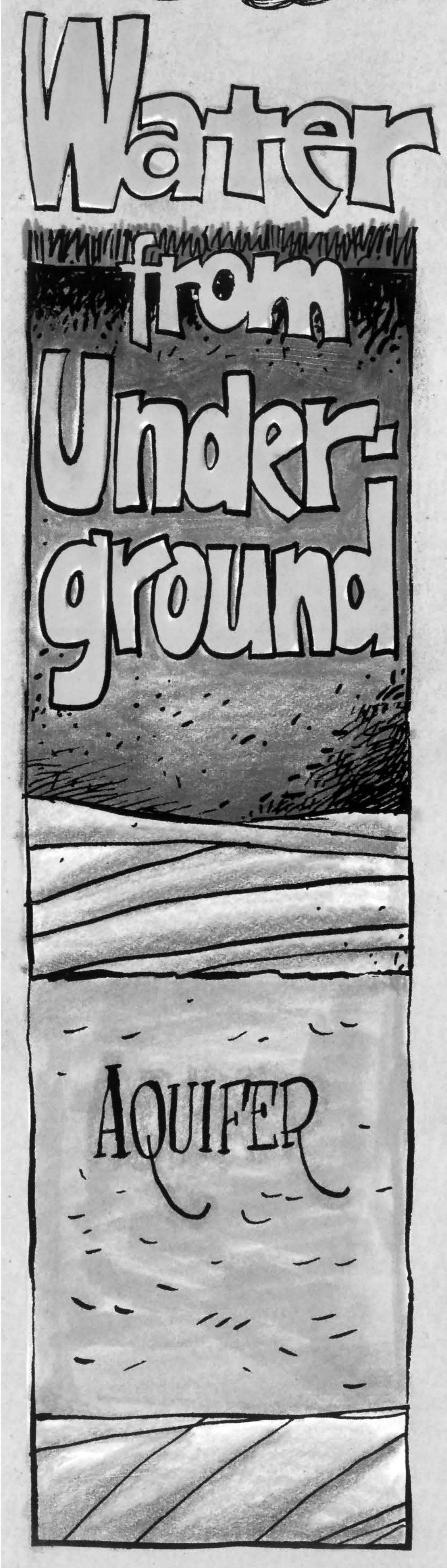


Fix the Map



In this map, some of the cities, towns and reservoirs in Santa Clara County are shown. But there is one problem. Some of the names are all scrambled up. Your job is to unscramble them, then write the correct names of the towns and reservoirs in the blanks below each one.

Water from Under-ground



Imported water takes care of about half of our needs. To get the other half, we pump water from underground. The buried water is called **GROUNDWATER**. We already learned that it collects in underground zones known as **AQUIFERS**.

Our aquifers are large sand and gravel beds covered by thick layers of topsoil and clay. Aquifers get their water from rain which soaks down through the ground. As mentioned earlier, this process is called **PERCOLATION**. As water trickles down, the soil acts as a filter, trapping many impurities.

The 10 reservoirs shown on page 4 collect some rainfall as it runs into creeks. As a rule, this water is much less polluted than rain that flows from city streets, through storm drains into San Francisco Bay.

Rainwater from the reservoirs, plus some imported water, flows into creeks. This water percolates down into the soil in the stream beds. As the water trickles down, the soil acts as a filter, trapping pollution from the surface. The water that percolates down becomes the groundwater in our underground aquifers.

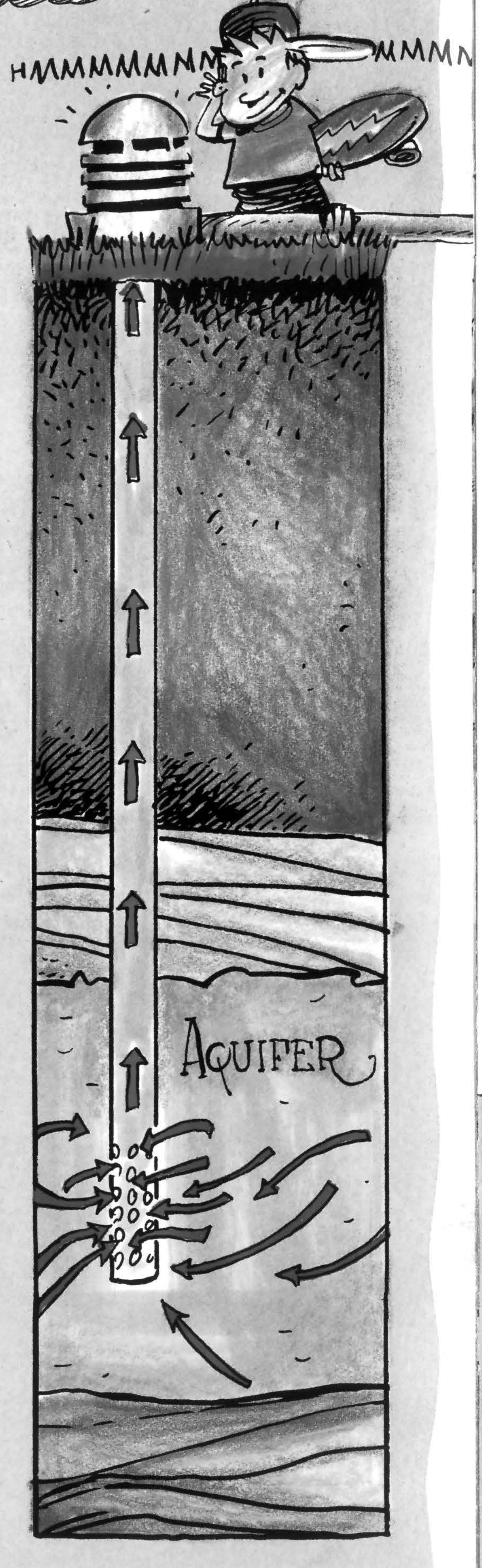
Aquifers spread out under large areas of the valley. Because they are so big, they can carry water many miles from where it first goes underground.

To get water up to the surface, water suppliers use **WELLS**. These are hollow shafts drilled down into the ground to the aquifer. Electric pumps force the water up to the surface. Pipes then carry the water to users. The soil purifies water naturally as it percolates, so groundwater does not need treatment.

In places with no wells, water can stay in aquifers for hundreds or even thousands of years. But, in the Santa Clara Valley, we take water from our aquifers every day. That is why we have to replace it.

To get more water down into the aquifers we dig out special percolation ponds. Using these ponds to put water into the underground aquifers is called **GROUNDWATER RECHARGE**. Engineers build the ponds where there are large areas of sand and gravel, so water will percolate easily.

By putting water into the ground we are able to clean it, store it, and make it available from wells throughout the Santa Clara Valley.



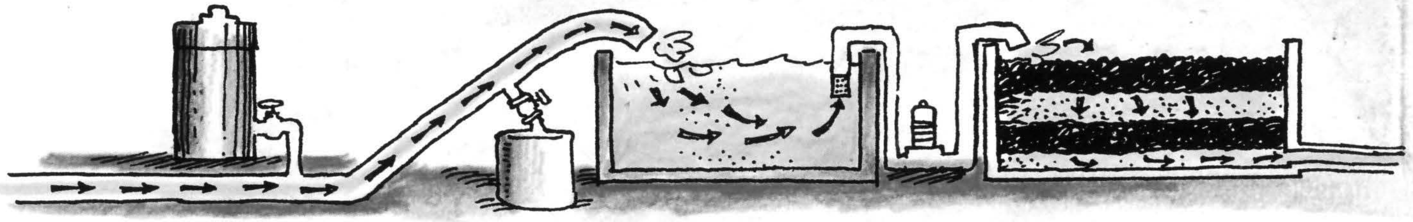
Water Treatment

Rainwater starts out almost pure in the clouds, but as it runs over the ground it becomes polluted with dirt and **BACTERIA** (germs). Even water that runs directly into streams gets dirty.

Dirt in water makes it look cloudy and taste bad. Bacteria can cause people to become sick. While percolation in the soil naturally filters groundwater, imported water needs to be cleaned. So treatment plants have been built to purify imported water.

Imported Hetch Hetchy water is cleaned before it gets to Santa Clara County. But, water imported from Shasta and Oroville is cleaned at three locations in the county: the Rinconada Water Treatment Plant in Los Gatos; the Penitencia Water Treatment Plant in northeast San Jose; and the Santa Teresa Water Treatment Plant in Almaden Valley.

All of these plants clean the water in three steps.

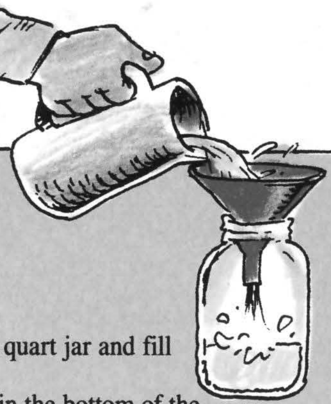


The first step is **DISINFECTION**. A safe chemical is added to the water to kill small organisms such as **BACTERIA**. Without disinfection, harmful bacteria might remain in the water, causing disease among people who drink it.

The second step is **CLARIFICATION**. In this step chemicals are used to attract the dirt in the water which causes cloudiness. As the chemicals and dirt combine, they get heavy, settle out of the water and are removed. After this step, the water looks clear.

The third step is **FILTRATION**. Here, charcoal and sand trap tiny particles still in the water as it flows through a filter bed. After the water has been filtered in the third step, it is pure and safe to drink.

Experiment



Filtration, described in step three, removes solid particles from water. This process cleans the water as it flows through layers of sand and gravel, just as percolation works with groundwater. This experiment shows how the filter beds in a treatment plant work.

GETTING READY

Assemble the following:

- 2 one-quart jars
- 1 large household funnel
- 1 cup sand
- 1 small package of cotton
- 1/2 cup garden soil
- 1 quart water

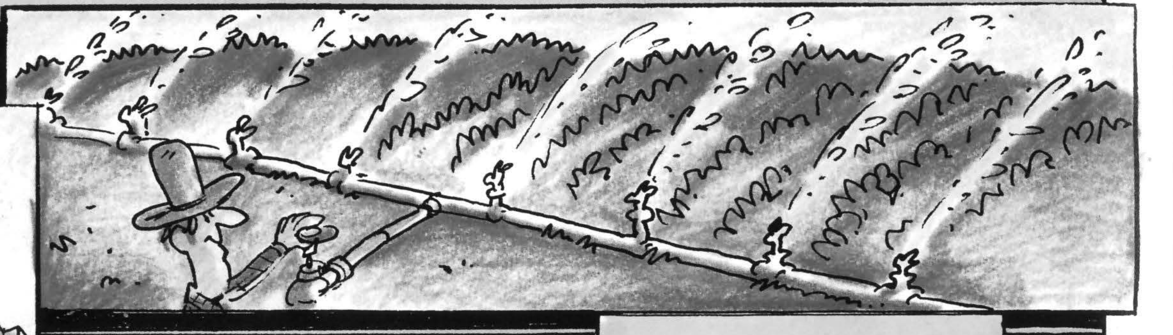
GETTING IT DONE

1. Place 1/2 cup of the garden soil in a quart jar and fill the jar with water.
2. Next, place a 2-inch layer of cotton in the bottom of the funnel.
3. Fill the rest of the funnel with sand.
4. Put the lid on the jar of water. Shake it up, then notice the appearance of the water.
5. Place an empty jar under the funnel; slowly pour dirty water from the jar into the funnel.
6. Describe the "treated water" after it has been filtered.
7. In what way is your experimental process like the process in a real treatment plant? In what ways is it different?

Water in Use

We've talked about how important water is to life. Now here is a chance for you to list some of the ways you know that water is used in the world around us.

For each drawing below, list at least two ways in which water is used. For Bonus Points, list additional ways that water might be used in its non-liquid form in any or all of the drawings.



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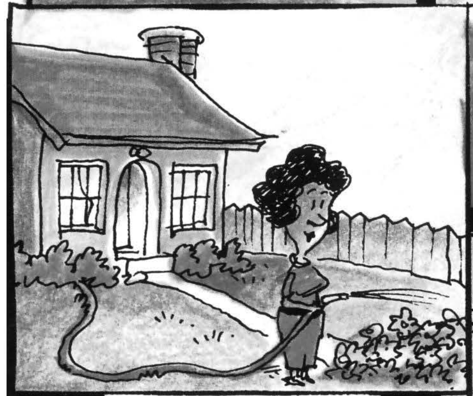

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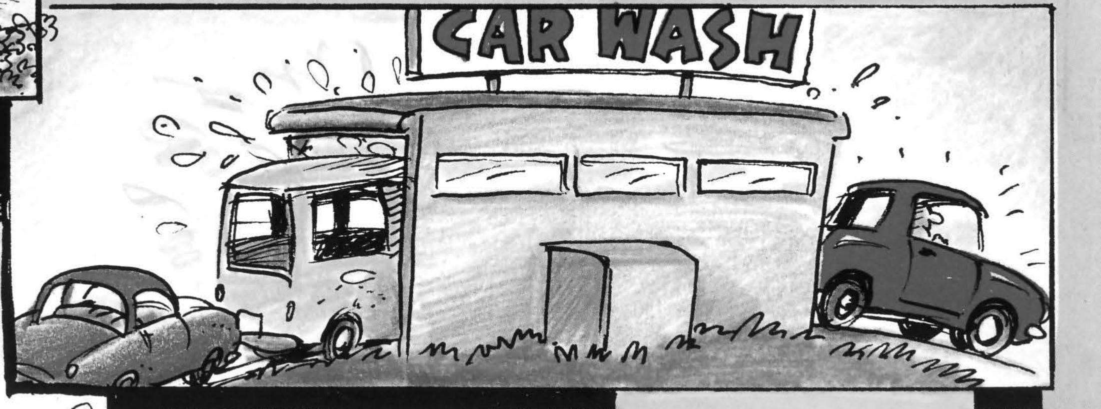

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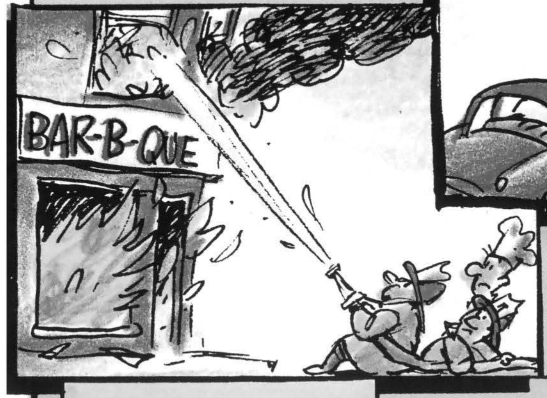

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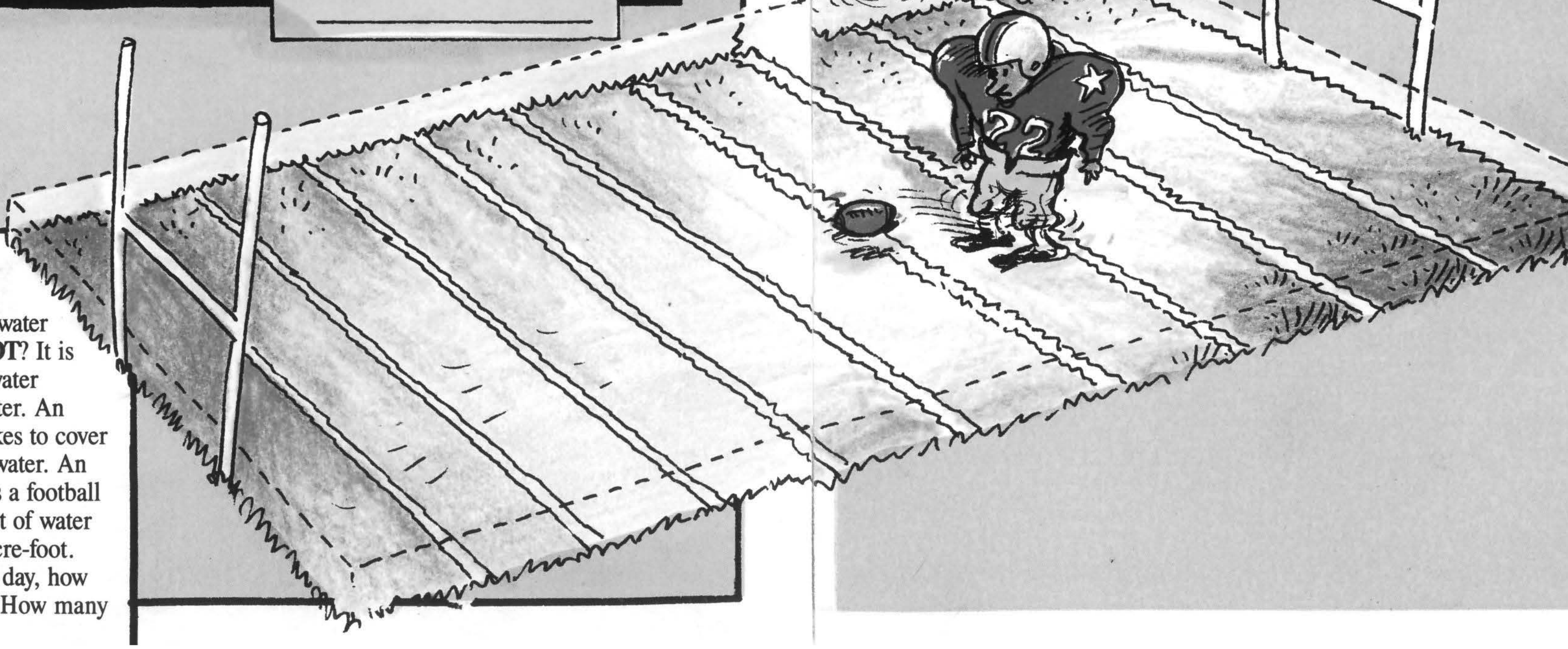
WHAT'S AN ACRE FOOT?
People in the Santa Clara Valley use an average of about 1,100 acre-feet of water every day. So what is an **ACRE-FOOT**? It is the measurement that people in the water business use for large amounts of water. An acre-foot is the amount of water it takes to cover an area of one acre with one foot of water. An acre is a piece of land about as big as a football field. To cover that area with one foot of water takes 325,829 gallons—that is one acre-foot. If we use 1,100 acre-feet of water per day, how many acre-feet do we use per year? How many gallons per year?



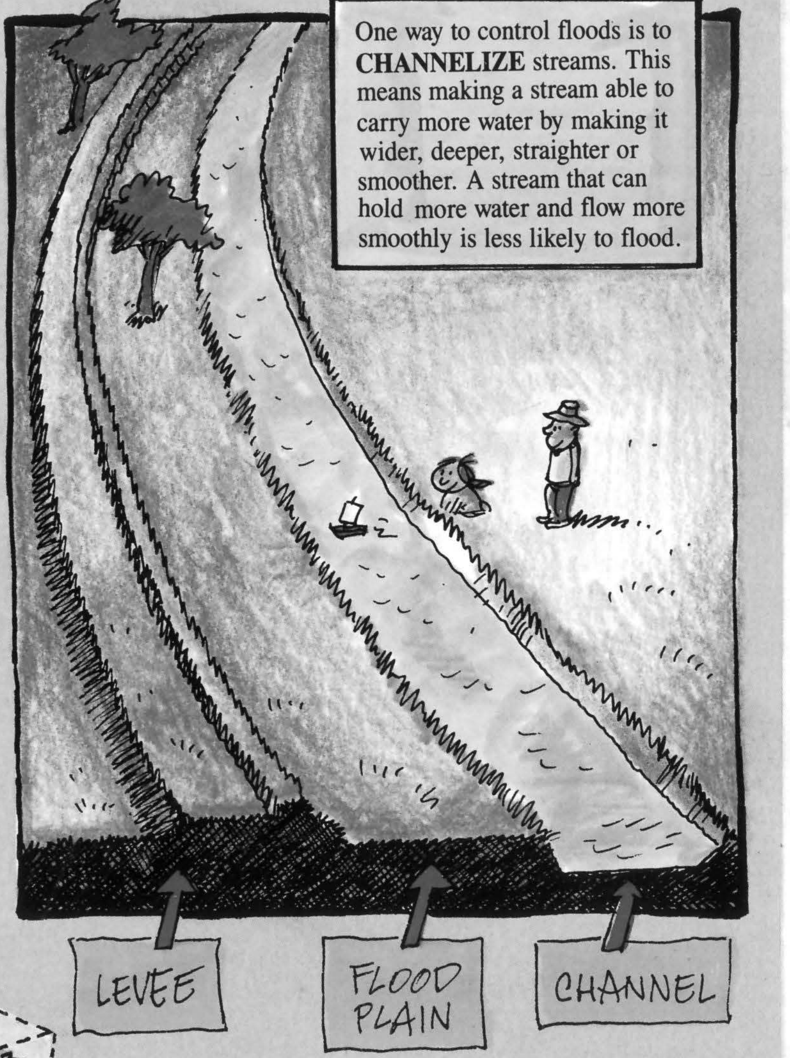
Too Much Water

One of the main problems in dealing with water is getting the right amount. If there is a drought we can have too little water. And if there are heavy storms or the snow in the mountains melts too fast, we can get too much water. Having too much can cause floods.

In the days of the early settlers, floods were a bigger problem than droughts. Almost any big storm caused flooding, mainly because very little was done to prevent flood damage. Farmhouses were built on high land, and the "ground floor" in most houses was usually built several steps above the ground to be above flood waters.

Whenever floods occur, they bring more than large amounts of water. Floods can wreck homes and offices, wash away property, kill people and animals and do all kinds of other damage.

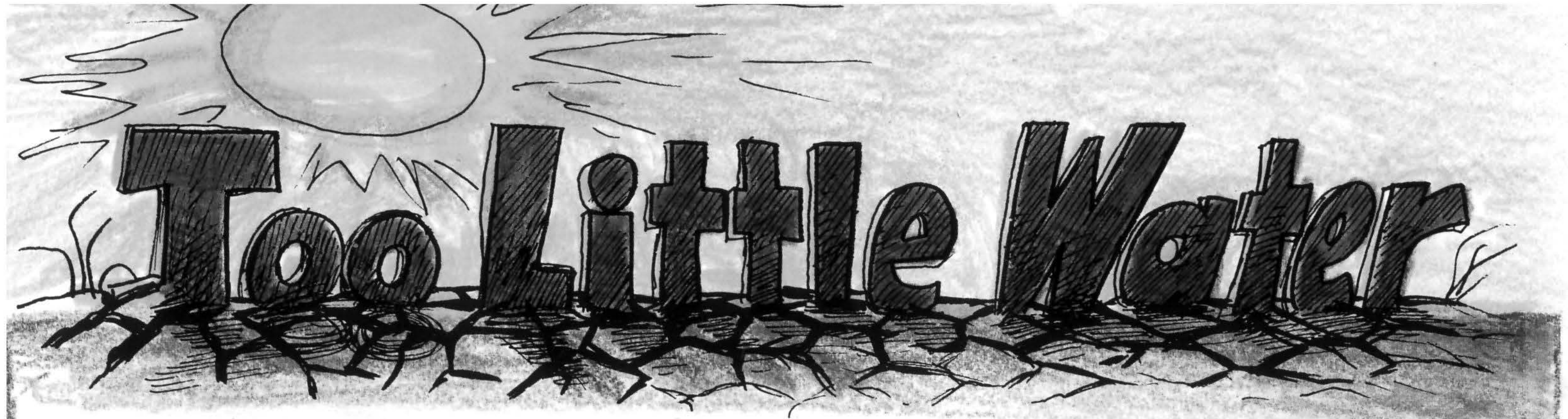
But these days we don't have much flooding any more—even during large storms. We have fewer floods because of **FLOOD CONTROL**, a program of the Santa Clara Valley Water District.



One way to control floods is to **CHANNELIZE** streams. This means making a stream able to carry more water by making it wider, deeper, straighter or smoother. A stream that can hold more water and flow more smoothly is less likely to flood.

The water district also builds **FLOOD PLAINS**. These are areas next to streams which can be flooded during storms without damage. Flood plains allow creeks to overflow safely. That way streams can be left in an almost natural condition. Floodwaters flow into temporary lakes instead of into homes or businesses.

One way everyone can help prevent floods is by not throwing trash into creeks. Old tires, tree trimmings, mattresses and just about any trash can build up and form a dam. These dams cause flooding. In addition, the trash can cause pollution in streams and even in San Francisco Bay.



Too Little Water

The previous page was about floods and things that are done to prevent them. But today, most of us are more familiar with the problems of too little water.

Usually, when we have a water shortage, it is from not getting enough rain or snow. A long period of time with very little rain is called a **DROUGHT**.

When this happens, reservoirs like Lake Shasta and San Luis Reservoir can get low. And when those reservoirs get low, there probably won't be enough water. At times like this we have a **WATER SHORTAGE**.

Until about 20 years ago, we didn't have water shortages in this area. But in 1976 and 1977 we got less than half of our normal 14 inches of rain. People quickly became very aware of the problems caused by water shortage. Then, in 1987, another drought began.

During times of short supply, everyone has to cut back on water use. In the drought of the late 1980s and early 1990s, people in Santa Clara County cut back on their water use by one-fourth! Many Californians had to cut back even more — as much as half in some areas. People did it, and so there was enough water for drinking, bathing, fire fighting, factories, and even some garden watering.

People found many ways to reduce water use. They took shorter showers. They washed only full loads of clothes and dishes. They didn't flush toilets needlessly. They washed their cars less. And they reduced garden watering. Some people even changed their gardens to plants that need very little water.

We may have even more dry times ahead, because population in our area has grown greatly. In 1950, around the time that many of today's parents were born, the population in Santa Clara County was only 290,000. Today there are more than five times as many people — more than 1.5 million. They all need water, so water demand continues to grow.

We have listed some of the ways people save water. What other things can we do to meet water needs if population keeps growing and water supplies don't?

Subsidence

Here's a word you may have never seen before — **SUBSIDENCE**. It's pronounced sub-**SIGH**-dense. Subsidence happens when the ground sinks because water has been removed from underneath.

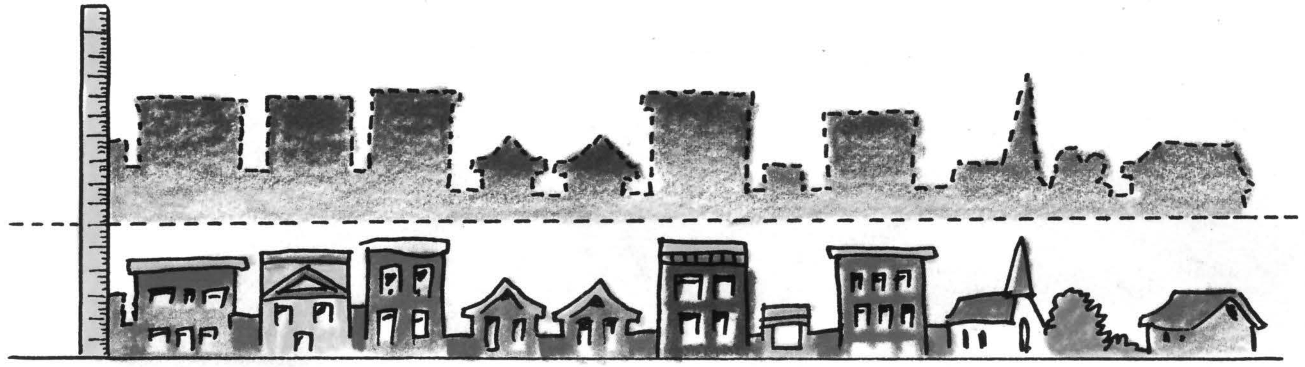
For example, if you had a stack of five books, and you took one book out of the middle of the stack, the stack wouldn't be as high. The same thing can happen if you pump too much water out of the ground.

Years ago, people in our valley took water from wells faster than rain could replace it. This **OVERDRAFTING** went on for about 50 years. As a result, there was subsidence. The ground slowly sank. Today there are places in downtown San Jose that are 13 feet lower than they used to be.

Subsidence hasn't been a problem for about 25 years. That is because we now replace groundwater as we pump it out, using imported water and percolation ponds.

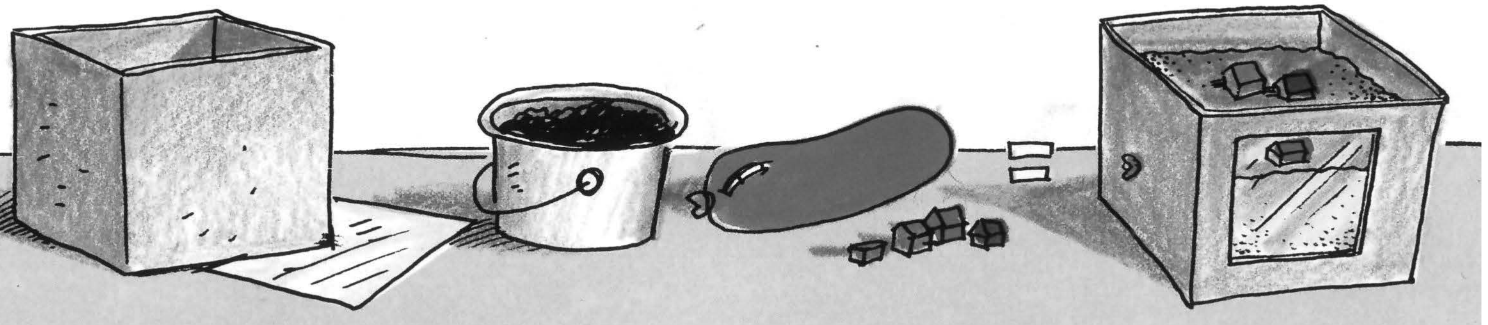
It was important to stop subsidence because it was causing buildings and streets to crack and pipelines to break. And the lower ground level meant greater danger of water from San Francisco Bay flowing backwards in creeks and causing floods.

Once the ground sinks, it will not rise again when more water percolates down. To prevent subsidence, we now avoid taking out too much water. We also try to keep extra water stored underground for drought needs. So, when the water district percolates water into the ground, it replaces water removed by wells, stores water for a drought and prevents subsidence.



That Sinking Feeling

Subsidence happens over a long period of time, but this experiment will show you in a hurry how it happens.



GETTING READY:

1. Get a cardboard box approximately 1' × 1' × 1' and a clear, plastic, 2 litre soft drink bottle with the label removed.
2. Cut a hole 9" high and 5" wide in the middle of the front of the box and tape a flat piece of plastic over the hole on the inside of the box. You can make the plastic covering by cutting the ends off of the soft drink bottle, then making another cut so that it will open up flat.
3. Cut a hole, 1" in diameter, in one of the sides of the box.
4. Place 3" of dirt in the bottom of the box.
5. Blow up a balloon to a length of 10", tie the end and place it in the box with the tied end sticking out of the 1" hole.
6. Fill the rest of the box with loose dirt and arrange some little model houses or buildings on top.

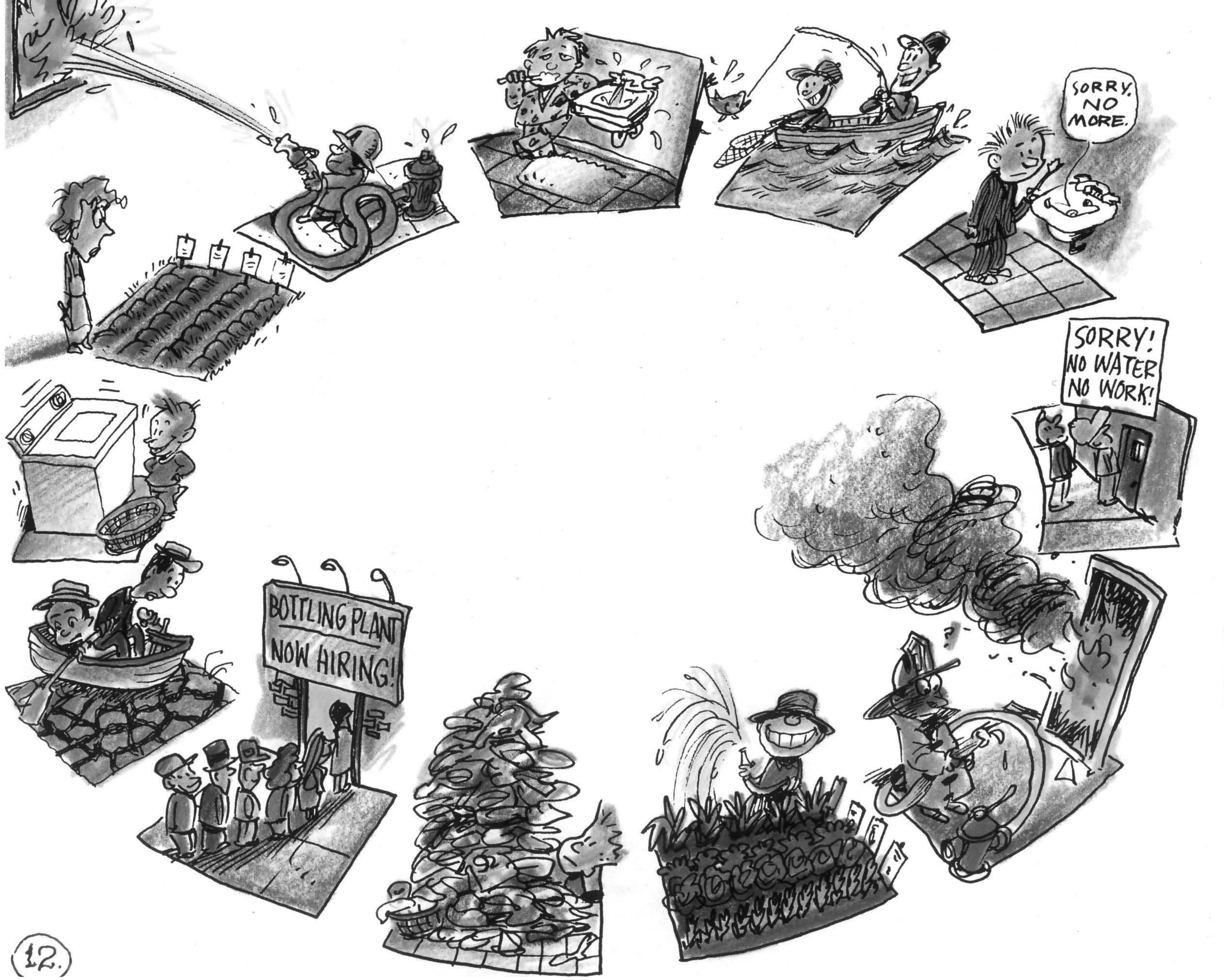
GETTING IT DONE

1. Untie the balloon and gradually let a little air escape. What happened to the dirt on the surface?
2. Slowly let more air escape. Watch the surface of the dirt and the buildings.
3. Continue the air release until there is some settling.
4. When all of the air has been removed from the balloon, note the results. How does this experiment compare with real life subsidence? What could have been done to prevent the settling?

What happens if we run short?

You've seen how important water is, and how using too much can cause subsidence. But water shortages cause many other problems in our lives, involving jobs, homes, safety and the environment.

The pictures below are "before-and-after" scenes, showing some of the things that might happen if the water supply gets too low. Draw lines connecting the normal scenes in the "Before" pictures with what could happen in a water shortage, as shown in the "After" drawings. Then, in the space provided, write down whether each pair of drawings involves jobs, home, safety or the environment.


SORRY. NO MORE.
SORRY! NO WATER NO WORK!
BOTTLING PLANT NOW HIRING!

How Low Can You Go?

Help prevent a water shortage — be water smart with water **CONSERVATION** (saving water). Water is like money — whatever we save will be there when we need it. Let's see how water smart you can be. Use the charts below to figure out how much water you use in a week. Then figure how much less you could use by being water smart.

CHART A
Figure out how much water you use in a week here.

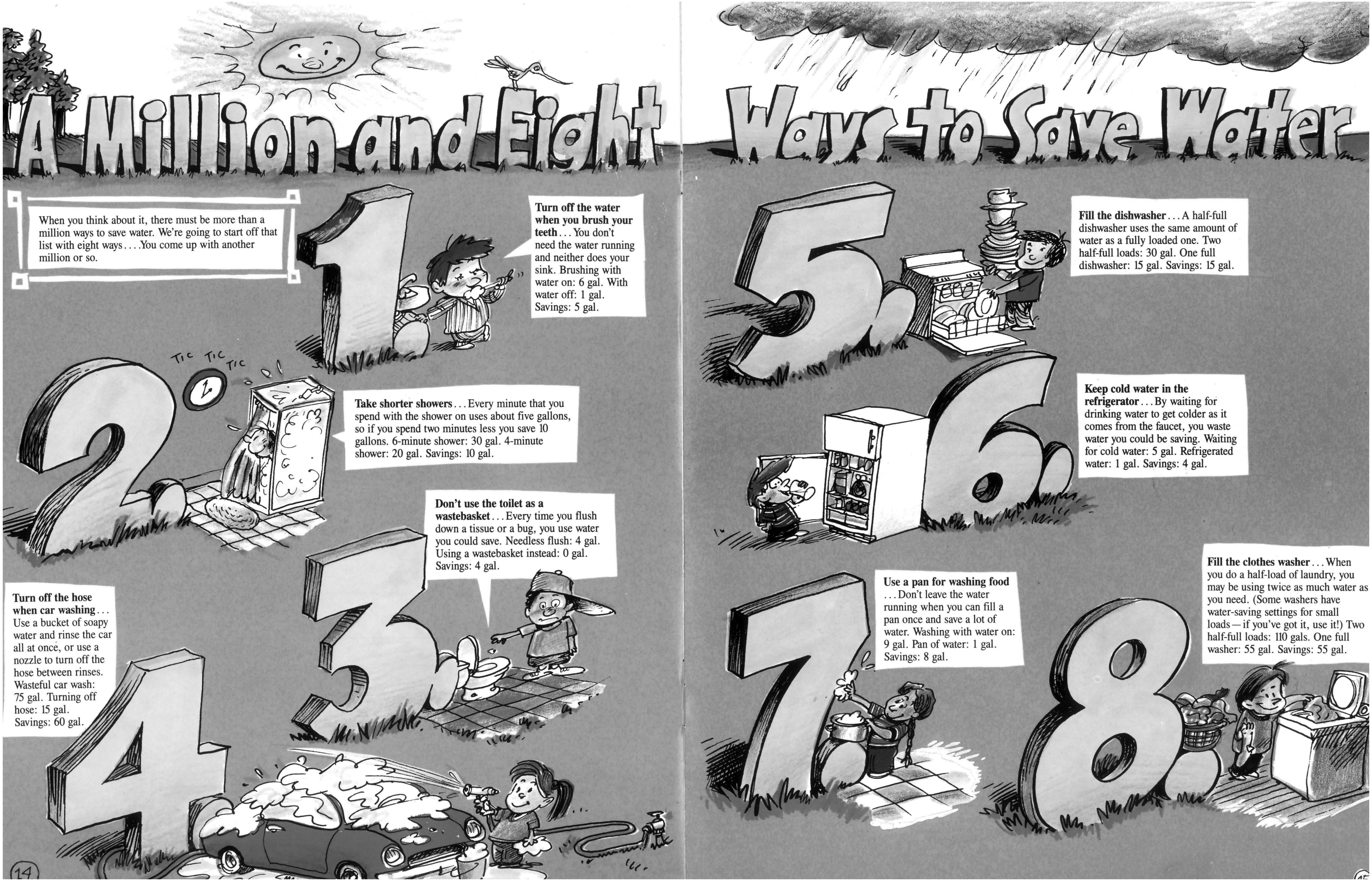
Toothbrushing: 6 gallons × ______ = ______ gallons.
(How many times do you brush your teeth per week?)
Showers: 42 gallons × ______ = ______ gallons.
Flushing: 5 gallons × ______ = ______ gallons.
Car Washing: 75 gallons × ______ = ______ gallons.
Total ______ gallons.

CHART B
Toothbrushing: 1 gallon × ______ = ______ gallons.
Showers: 28 gallons × ______ = ______ gallons.
Flushing: 4 gallons × ______ = ______ gallons.
Car Washing 15 gallons × ______ = ______ gallons.
Total ______ gallons.

	GRAPH A	**GRAPH B**
400		
380		
360		
340		
320		
300		
280		
260		
240		
220		
200		
180		
160		
140		
120		
100		
80		
60		
40		
20		
0		

Now take the total gallons from Chart A and record it on Graph A. Do the same for the total gallons from Chart B on Graph B. Compare the two graphs to see how much water you save by being water smart.

A Million and Eight Ways to Save Water



When you think about it, there must be more than a million ways to save water. We're going to start off that list with eight ways. . . . You come up with another million or so.

1. **Turn off the water when you brush your teeth** . . . You don't need the water running and neither does your sink. Brushing with water on: 6 gal. With water off: 1 gal. Savings: 5 gal.

2. **Take shorter showers** . . . Every minute that you spend with the shower on uses about five gallons, so if you spend two minutes less you save 10 gallons. 6-minute shower: 30 gal. 4-minute shower: 20 gal. Savings: 10 gal.

3. **Don't use the toilet as a wastebasket** . . . Every time you flush down a tissue or a bug, you use water you could save. Needless flush: 4 gal. Using a wastebasket instead: 0 gal. Savings: 4 gal.

4. **Turn off the hose when car washing** . . . Use a bucket of soapy water and rinse the car all at once, or use a nozzle to turn off the hose between rinses. Wasteful car wash: 75 gal. Turning off hose: 15 gal. Savings: 60 gal.

5. **Fill the dishwasher** . . . A half-full dishwasher uses the same amount of water as a fully loaded one. Two half-full loads: 30 gal. One full dishwasher: 15 gal. Savings: 15 gal.

6. **Keep cold water in the refrigerator** . . . By waiting for drinking water to get colder as it comes from the faucet, you waste water you could be saving. Waiting for cold water: 5 gal. Refrigerated water: 1 gal. Savings: 4 gal.

7. **Use a pan for washing food** . . . Don't leave the water running when you can fill a pan once and save a lot of water. Washing with water on: 9 gal. Pan of water: 1 gal. Savings: 8 gal.

8. **Fill the clothes washer** . . . When you do a half-load of laundry, you may be using twice as much water as you need. (Some washers have water-saving settings for small loads — if you've got it, use it!) Two half-full loads: 110 gals. One full washer: 55 gal. Savings: 55 gal.

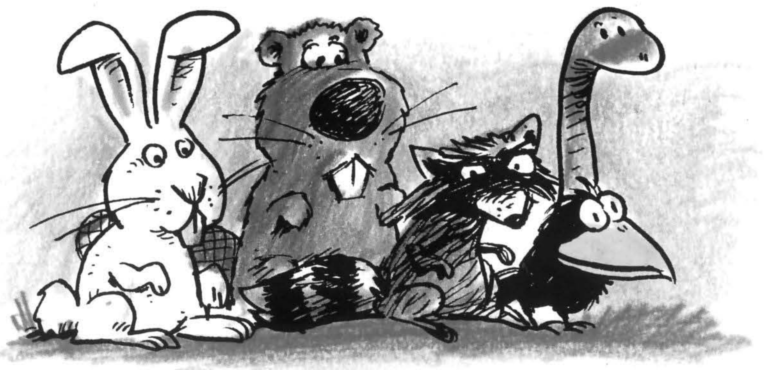
Water Quality

The water problems we have discussed so far have to do with quantity — too much or too little. But there are other water problems, having to do with quality. These are problems of **POLLUTION**, caused by impurities which make the water unusable for humans and unsafe for some plants, fish and wildlife.

Pollution of our drinking water makes it unusable for drinking, cooking or washing. That is why water from streams goes through treatment plants before we use it. But there are also problems of quality in water we never use — water which is important to the survival of animals and plants in the environment.

Some water pollution is natural, caused by plants, animals and minerals in nature. For example, dead plants and animals in water cause **ORGANIC POLLUTION**. As they decay, they use oxygen and create gasses and chemical compounds that lower water quality.

And water that contains certain kinds of mineral deposits, such as copper, can be poisonous to some fish and plants. This is known as **INORGANIC POLLUTION**.



But, natural purification cleans up most natural pollution. Bacteria and other microscopic life in water cause the organic matter to break down into non-polluting substances. Inorganic materials from nature form salts and wash to sea.

Natural pollution, however, is only a small fraction of the problem. By far the greatest source of our water quality problems is humans.

People create amazing amounts of waste. Even with recycling and other efforts at reducing wastes, humans can create more waste and cause more pollution than our environment can clean up by itself. If nature can't cleanse all the impurities we put into the environment, plant and animal life — including humans — will suffer.

Some of the wastes created by people end up in landfills (dumps) and some pollutants get into the air. Many wastes find their way into our water.

When they think of water pollution sources, most people think of factories and refineries. This is known as **POINT SOURCE POLLUTION** because the source of the pollution can be traced to an exact point.

Another source of water pollution, and one that many people don't think about, is rainwater. Rain seems like it should be clean. But, in fact, it picks up some impurities from air pollution, then, as it runs over the ground, water from rain collects many more impurities.

In populated areas such as the Santa Clara Valley, stormwater runoff flows off of roofs, yards, streets, parking lots and other surfaces. It goes down gutters into storm drains, empties into streams and finally pours into San Francisco Bay. Because the runoff comes from so many sources, it is called **NONPOINT SOURCE POLLUTION**.

Point Source Pollution

Point source pollution comes from a single point, such as a home or business. Drains at these sources are connected to a sewer system. The pipelines carry the wastes to **WASTEWATER TREATMENT** plants. These plants clean up the wastewater so it can go into the Bay.

But treatment plants are unable to remove certain types of pollutants. For example, **HEAVY METALS** such as copper, nickel, lead and zinc can remain in the water that flows to the Bay. These metals can harm and even kill fish and wildlife.

Point source pollution can come from businesses that use water to make a product. If the business puts wastes into a sewer for treatment, it can cause point source pollution. Restaurants and canneries, for example, use water in cooking food and washing equipment. Companies that make printed circuit boards and chips for computers also have to take great care not to be point source polluters.

Oil refineries and chemical plants are other examples of possible point sources. They produce or use oil-based chemicals that can cause pollution if not carefully managed.

New methods and equipment make it easier to clean up wastes than in the past. And water quality laws now require such "dischargers" to clean up their used water before sending it to wastewater treatment plants.

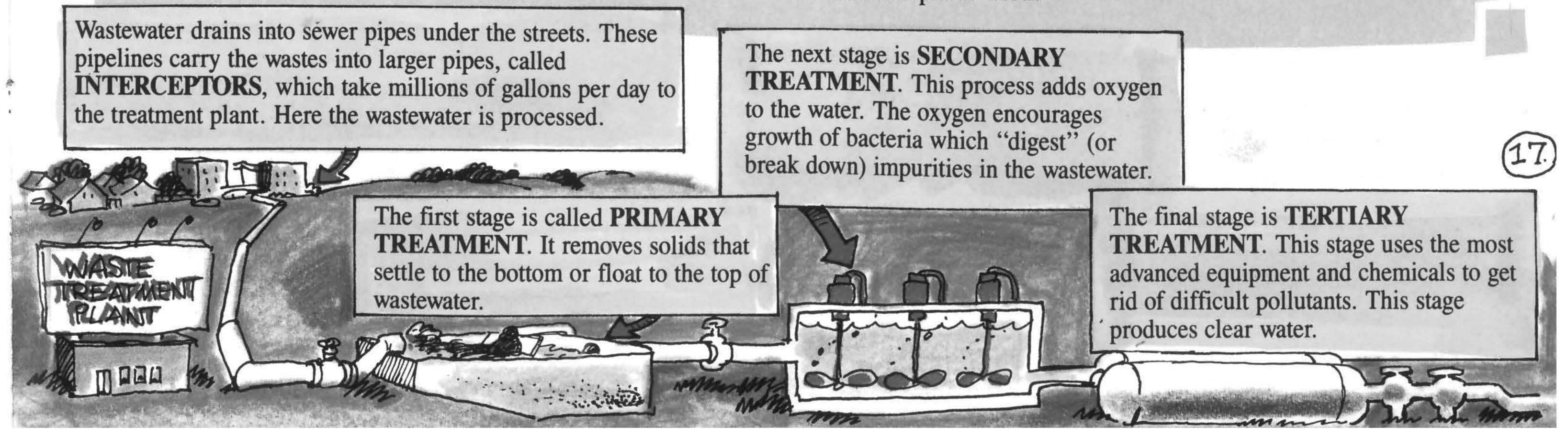
Even so, it is a never-ending job to make sure the Bay is protected.

How They Clean Up Wastewater

Sewers are the drains that carry wastes away from homes and businesses. The **SEWAGE**, or **WASTEWATER**, flows through underground pipelines to treatment plants. These plants remove organic pollutants. But metals and other inorganic pollutants cannot be removed by sewage treatment plants. These chemicals can pollute surface waters if they get into the waste stream.

Storm drains are also underground pipelines. They are designed to carry away stormwater. Flows in the storm drains are called stormwater runoff, and are discussed on page 19.

Cleaning up wastewater is an important job. Wastewater treatment prevents a major source of pollution. Here is how most sewage treatment plants work.

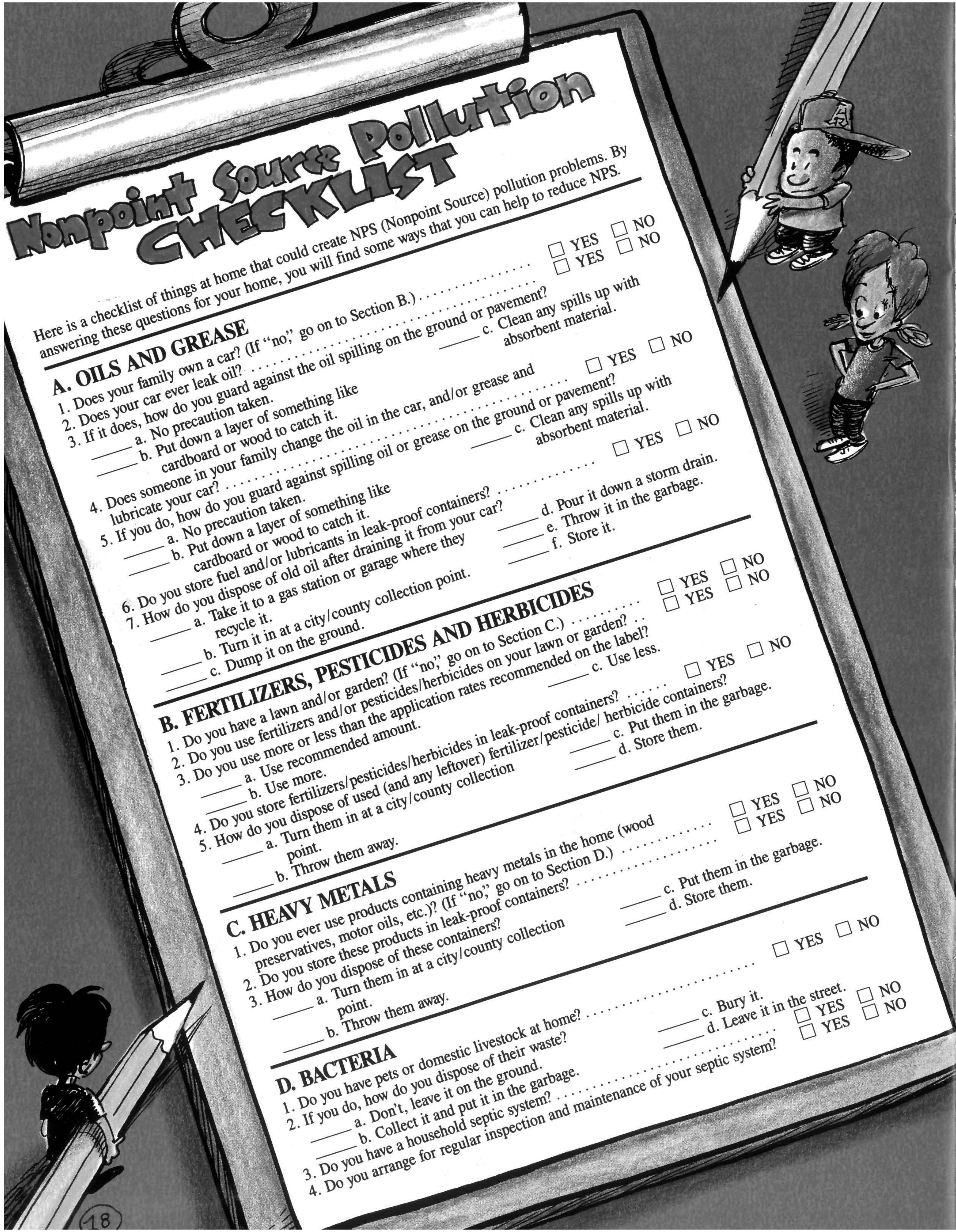


Wastewater drains into sewer pipes under the streets. These pipelines carry the wastes into larger pipes, called **INTERCEPTORS**, which take millions of gallons per day to the treatment plant. Here the wastewater is processed.

The first stage is called **PRIMARY TREATMENT**. It removes solids that settle to the bottom or float to the top of wastewater.

The next stage is **SECONDARY TREATMENT**. This process adds oxygen to the water. The oxygen encourages growth of bacteria which "digest" (or break down) impurities in the wastewater.

The final stage is **TERTIARY TREATMENT**. This stage uses the most advanced equipment and chemicals to get rid of difficult pollutants. This stage produces clear water.



Nonpoint Source Pollution CHECKLIST

Here is a checklist of things at home that could create NPS (Nonpoint Source) pollution problems. By answering these questions for your home, you will find some ways that you can help to reduce NPS.

A. OILS AND GREASE

1. Does your family own a car? (If "no," go on to Section B.) .... ☐ YES ☐ NO
2. Does your car ever leak oil? .... ☐ YES ☐ NO
3. If it does, how do you guard against the oil spilling on the ground or pavement?
   _____ a. No precaution taken.
   _____ b. Put down a layer of something like cardboard or wood to catch it.
   _____ c. Clean any spills up with absorbent material.
4. Does someone in your family change the oil in the car, and/or grease and lubricate your car? .... ☐ YES ☐ NO
5. If you do, how do you guard against spilling oil or grease on the ground or pavement?
   _____ a. No precaution taken.
   _____ b. Put down a layer of something like cardboard or wood to catch it.
   _____ c. Clean any spills up with absorbent material.
6. Do you store fuel and/or lubricants in leak-proof containers? .... ☐ YES ☐ NO
7. How do you dispose of old oil after draining it from your car?
   _____ a. Take it to a gas station or garage where they recycle it.
   _____ b. Turn it in at a city/county collection point.
   _____ c. Dump it on the ground.
   _____ d. Pour it down a storm drain.
   _____ e. Throw it in the garbage.
   _____ f. Store it.

B. FERTILIZERS, PESTICIDES AND HERBICIDES

1. Do you have a lawn and/or garden? (If "no," go on to Section C.) .... ☐ YES ☐ NO
2. Do you use fertilizers and/or pesticides/herbicides on your lawn or garden? .. ☐ YES ☐ NO
3. Do you use more or less than the application rates recommended on the label?
   _____ a. Use recommended amount.
   _____ b. Use more.
   _____ c. Use less.
4. Do you store fertilizers/pesticides/herbicides in leak-proof containers? ...... ☐ YES ☐ NO
5. How do you dispose of used (and any leftover) fertilizer/pesticide/ herbicide containers?
   _____ a. Turn them in at a city/county collection point.
   _____ b. Throw them away.
   _____ c. Put them in the garbage.
   _____ d. Store them.

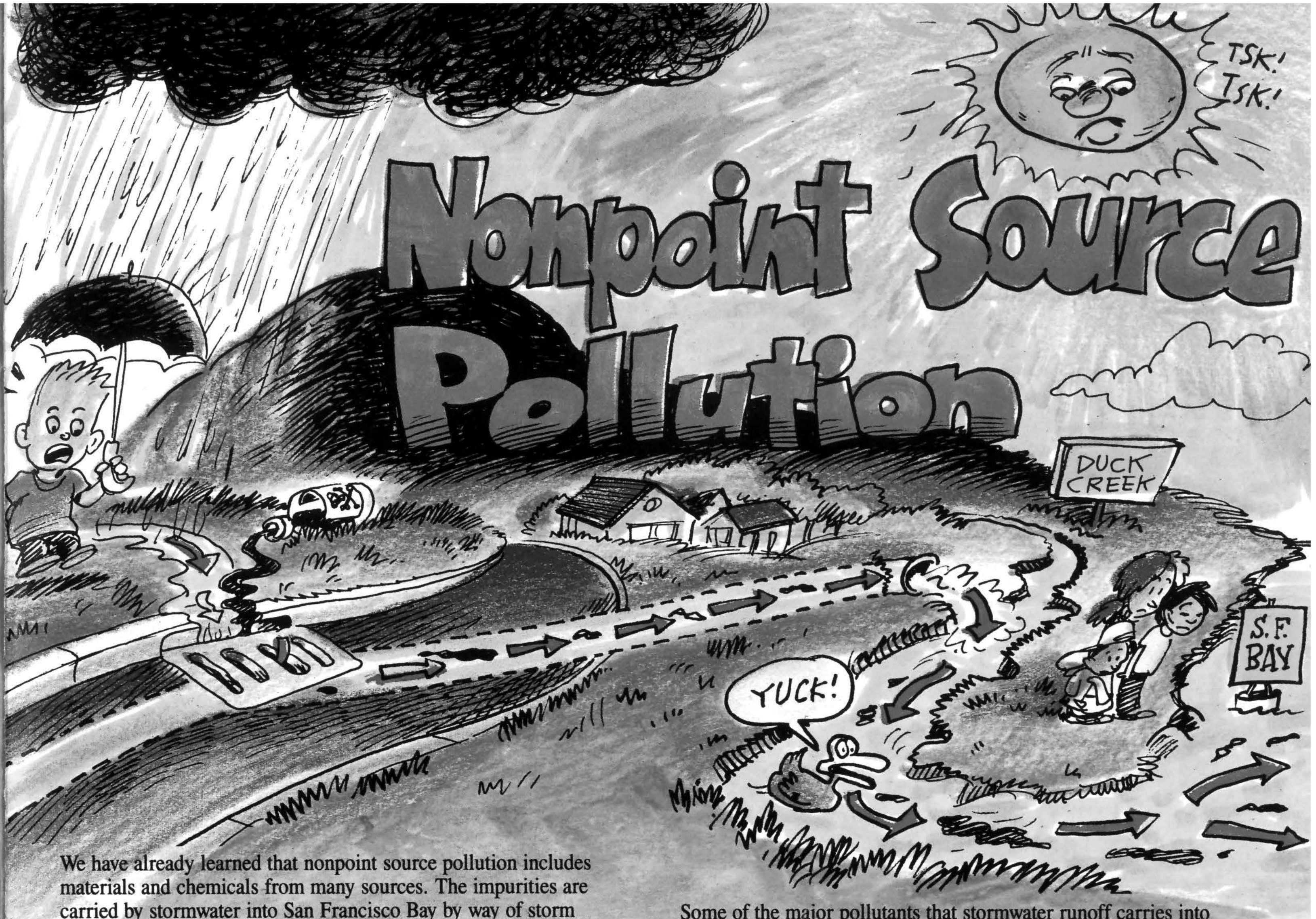
C. HEAVY METALS

1. Do you ever use products containing heavy metals in the home (wood preservatives, motor oils, etc.)? (If "no," go on to Section D.) .... ☐ YES ☐ NO
2. Do you store these products in leak-proof containers? .... ☐ YES ☐ NO
3. How do you dispose of these containers?
   _____ a. Turn them in at a city/county collection point.
   _____ b. Throw them away.
   _____ c. Put them in the garbage.
   _____ d. Store them.

D. BACTERIA

1. Do you have pets or domestic livestock at home? .... ☐ YES ☐ NO
2. If you do, how do you dispose of their waste?
   _____ a. Don't, leave it on the ground.
   _____ b. Collect it and put it in the garbage.
   _____ c. Bury it.
   _____ d. Leave it in the street.
3. Do you have a household septic system? .... ☐ YES ☐ NO
4. Do you arrange for regular inspection and maintenance of your septic system? ☐ YES ☐ NO

Nonpoint Source Pollution


TSK! TSK!
DUCK CREEK
S.F. BAY
YUCK!

We have already learned that nonpoint source pollution includes materials and chemicals from many sources. The impurities are carried by stormwater into San Francisco Bay by way of storm drains and local creeks.

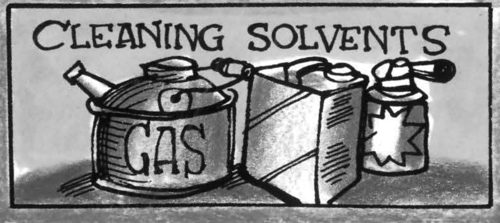
Since this water comes mostly from rain and "just runs over the ground," it might not seem like a serious pollution problem. But, in fact, **nonpoint source pollution is the source of about half of the pollution entering San Francisco Bay**.

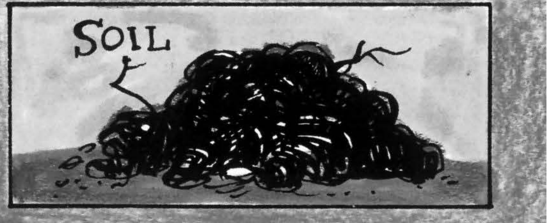
Nonpoint source pollutants come from streets, homes, farms, construction sites and parking lots. Rain and other water washes them into streams and storm drains.

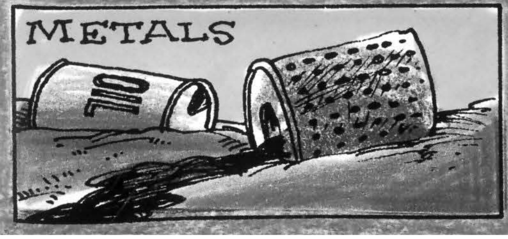
Nonpoint source pollutants flow into an underground web of storm drains. These pipelines are separate from the wastewater treatment plant sewer system we read about on page 17. Storm drain systems wash nonpoint source pollutants directly into the Bay without treatment.

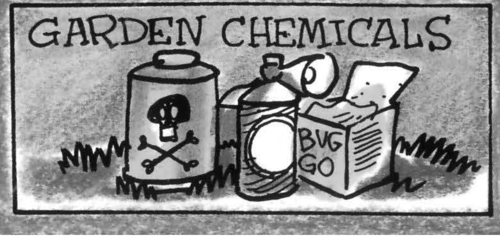
Some of the major pollutants that stormwater runoff carries into the Bay are:

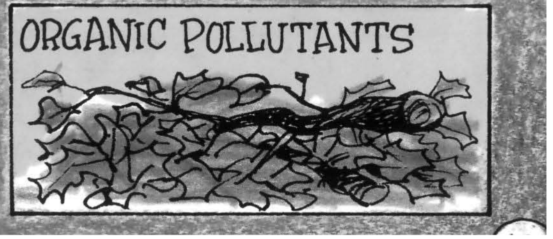
- **Oil, Grease, Antifreeze, Gasoline and Diesel Fuel.** Sometimes these are dumped on the ground or into storm drains. They also come from leaks in cars, trucks and buses.
- **Metals.** These are often found in vehicle exhaust, weathered paint, metal plating, tires and old motor oil.
- **Cleaning SOLVENTS** (fluids used to remove stains). This type of poisonous compound can be carelessly dumped from homes and businesses.
- **Garden Chemicals.** Insect and weed poisons are killers, and fertilizers cause problems too.
- **Soil.** Washed from lawns, hillsides and construction sites.
- **Organic Pollutants.** These come from litter and from animal and plant wastes.











What's The Problem?

Let's say that some pollutant like oil gets dumped on the ground . . . in a vacant lot . . . on a sunny day . . . 20 miles from the Bay. What's the harm?

Well, for one thing, even during a drought we still get rain. And, while some of the rainwater soaks into the ground, more runs off, carrying pollutants with it.

You've seen "rainbow" oil spots in the street, running down the gutter. And think about the extra-slippery streets when it first rains after a long dry spell. That's a mixture of rainwater and pollutants, and it pours directly into storm drains. If you live or go to school near any creeks or flood control channels, you know how full they become with rainwater spilling out of storm drains.

That water goes down the drains, down the creeks and down flood control channels. And from the moment it hits the earth, stormwater runoff picks up pollutants that people have left on the ground, in storm drains and in creek beds.

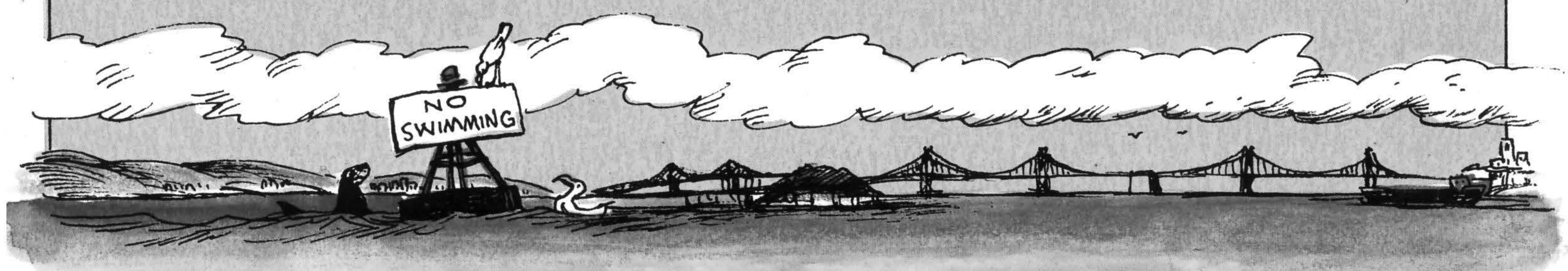
Things like litter, oil, gasoline, paint thinner—whatever is carelessly discarded. They wash into the nearest storm drain or creek when it rains. These pollutants can last for months. They only "go away" when the rains come, and then only as far as the nearest stream. Many end up in San Francisco Bay.

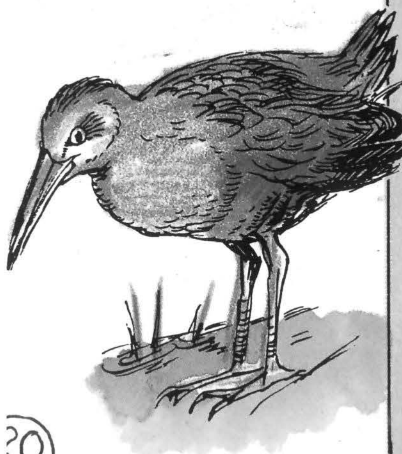
When they reach San Francisco Bay, these pollutants really harm water quality. In some places the bottom of the Bay is covered with polluted dirt. Water in the Bay is polluted by runoff containing high levels of poisonous chemicals. And decaying matter robs oxygen from plants and animals.

The pollutants could be organic, such as garden clippings and animal wastes. Or they might be inorganic, like oils and household chemicals. Either way, they are nonpoint source pollutants and they harm wildlife.

Because the actions of people create most nonpoint source pollution, population growth seriously adds to the problem. There are now more than six million people in the Bay area, nearly twice as many as in 1960.

Newcomers, visitors, even new babies are a new source of pollution. Each represents more cars, more streets and more homes and gardens. They all add to the pollutant load flowing into the Bay.





About our Endangered Species

Did you know the South Bay has two native animals that are in danger of being killed off?

One is the salt marsh harvest mouse, a seldom-seen resident around the edges of the Bay. Although we rarely see this little creature, it is an important source of food for larger animals.

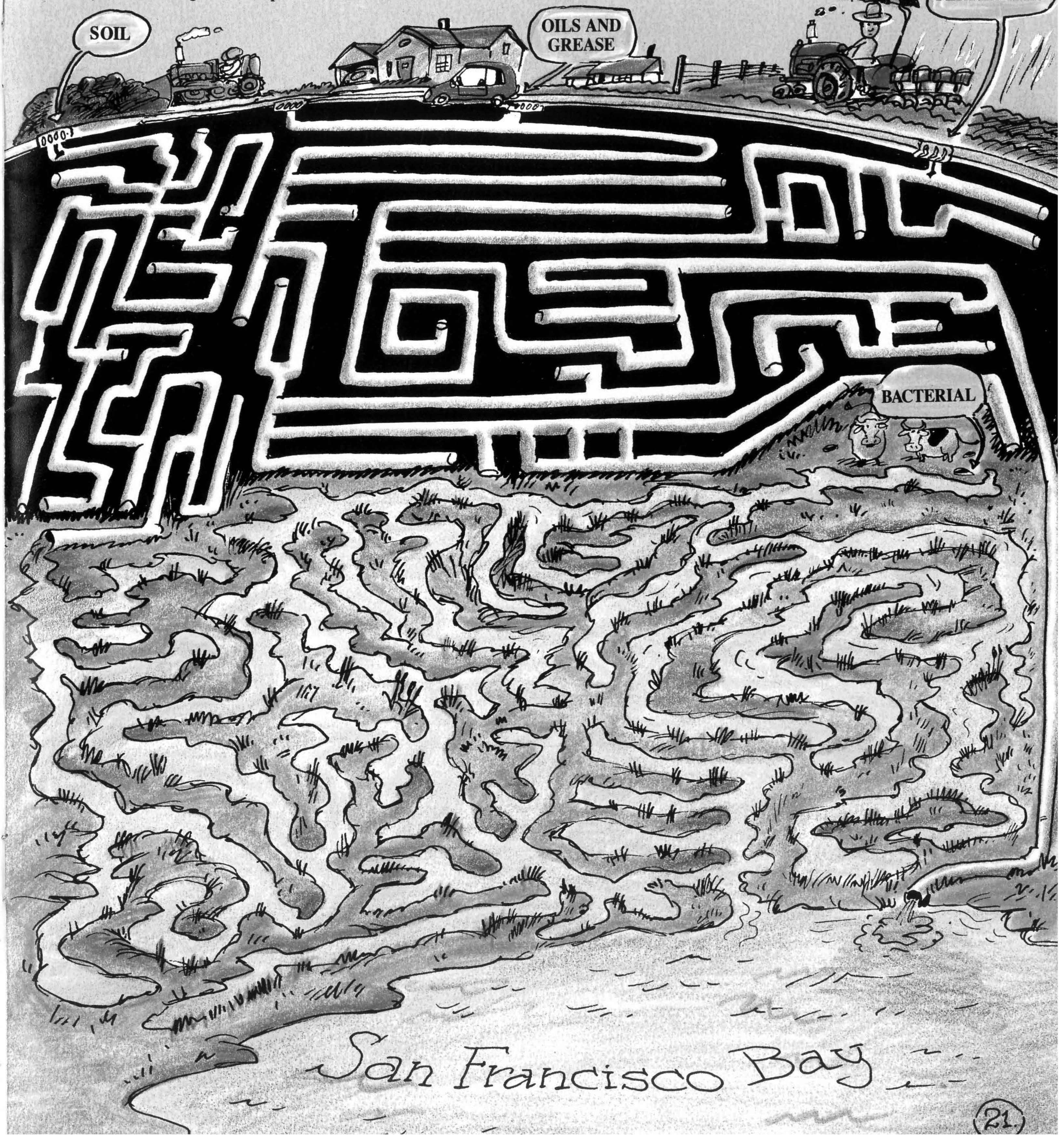
The other is the California clapper rail, a shorebird that was once plentiful in wetlands along the water's edge. Today it is in danger of becoming extinct because its habitat and food sources (including the harvest mouse) are disappearing.

In addition, fishermen will tell you that striped bass are becoming rare. Experts estimate the striper population in the Bay today is less than one-fourth of what it was a few years ago.

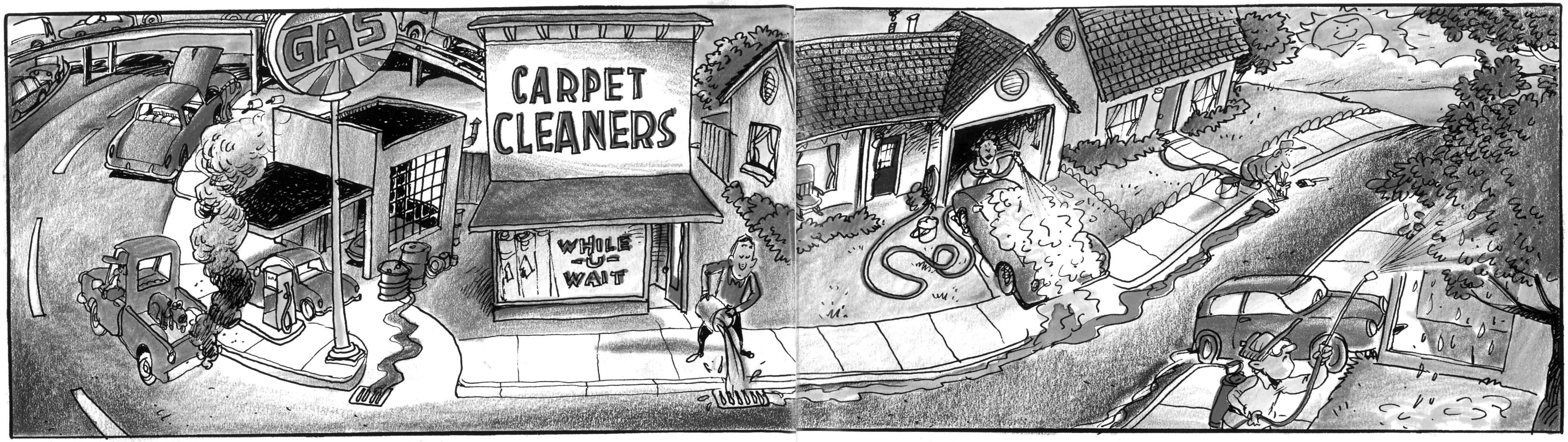
We know that nonpoint source pollution is not the only threat these creatures face. We also know that cleaner surroundings improve their chances of survival.

NONPOINT SOURCE POLLUTION MAZE

Can you trace the paths of the four types of nonpoint source pollutants from their origins to the Bay? Using the codes indicated below, mark each route on the maze. Then, on a separate piece of paper, write a brief explanation of how each pollutant got into its particular path, and all the harmful effects you think it might have on plant and animal life in streams and in San Francisco Bay.



Nonpoint Source Pollution... What To Do About It.



Many of our nonpoint source pollution problems come from things we do around home and with our cars. The more people there are, the worse these problems get—UNLESS . . .

- —UNLESS we stop dumping oil and other auto products.
- —UNLESS we use garden chemicals carefully.
- —UNLESS we take better care of cars.
- —UNLESS we discard household chemicals properly.

By being a little more careful in our daily lives, we can take a huge step in cleaning up San Francisco Bay.

Here are some ways you can help.

Cars and Trucks—

- —Take old oil, gas and antifreeze to gas stations that recycle, or to a community hazardous waste collection day. Put pollution in its place.
- —Make sure the car is in good running condition—this cuts down on leaks and air pollution.
- —Cars are one of the biggest pollution sources. Take a bus, bike or carpool—a great way to get the **BIG POLLUTER.**
- —When you wash the car, do it on the lawn using biodegradable soap . . . and remember to use a shutoff nozzle to save water.
- —Don't wash driveways down with soaps or solvents.

In the House—

- —Take unwanted hazardous household chemicals to a community collection day . . . things like old paints, dyes, insect killers, solvents and cleaners.
- —Store leftover chemicals in sealed containers—and keep them out of reach of animals and small children.
- —If one of these chemicals gets spilled, clean it up with kitty litter or some other material that will soak it up . . . then dispose of it properly.
- —Clean water-base paintbrushes and rollers in the sink, not in the driveway or gutter.
- —Buy household cleaners and solvents marked "Non-Toxic"—they don't pollute.

In the Yard—

- —Follow the directions on plant sprays and fertilizers—don't overdose the environment.
- —Take old garden chemicals to a community collection day . . . they will be disposed of properly.
- —Arrange downspouts so that rain coming off the roof waters the lawn—the grass helps filter out pollution.
- —When watering plants, avoid sidewalks, driveways and gutters—they don't need it.
- —Recycle garden clippings in your city's yard waste program, or use a compost pile away from driveways or streets.
- —Clean up pavement with a broom, not a hose—that keeps decay out of the bay.

San Francisco Bay is a special place—please do your part to protect it. Remember . . .

. . . The Bay Begins at Your Front Door!

What else is Happening?

Nonpoint source pollution has become a big enough problem in the South Bay that a group has been formed to help fight it. Its name is the Santa Clara Valley Nonpoint Source Pollution Control Program. Members are 13 cities and towns, plus the county and the water district. They have begun a long-term program to fight nonpoint source pollution throughout Santa Clara County.

Even before the group was formed, cities were spending millions of dollars every year on cleanup programs. They sweep streets, pick up litter, clean storm drains and collect trash and hazardous wastes.

The Santa Clara Valley Nonpoint Source Pollution Control Program is finding new ways to reduce the problem. One way is to alert people through news stories, talks and school materials such as this book. And there are many other ways that nonpoint source pollution is being fought in the South Bay.

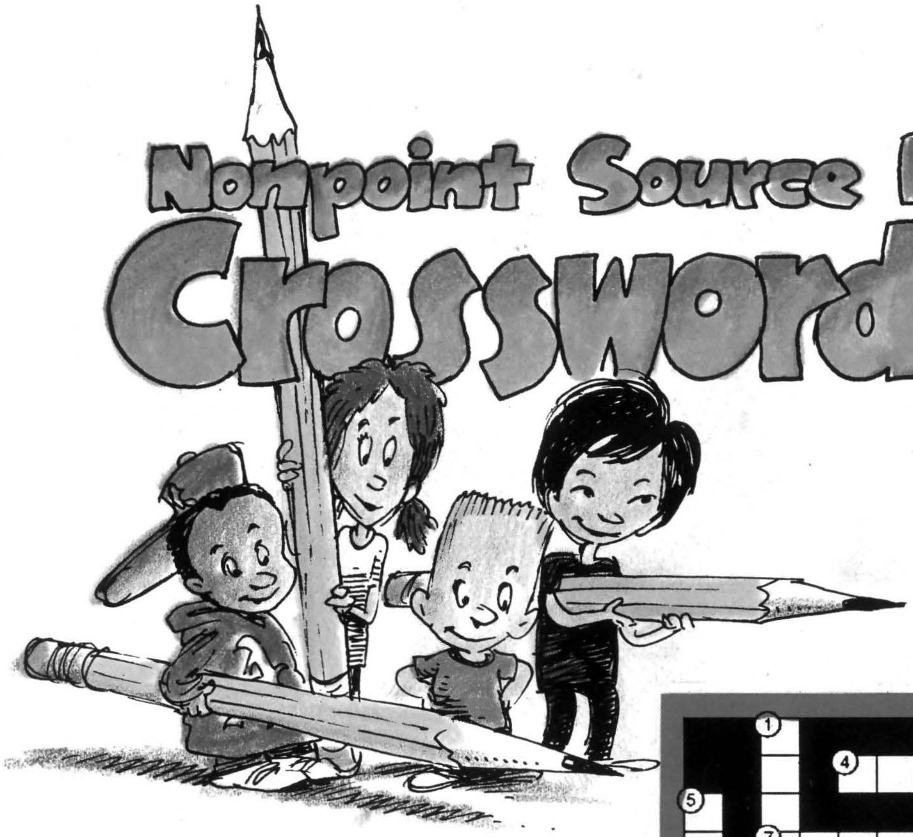
For example, city employees work to keep pollutants from getting into storm drain systems. They also are hoping to remove some pollutants from stormwater before they reach the Bay.

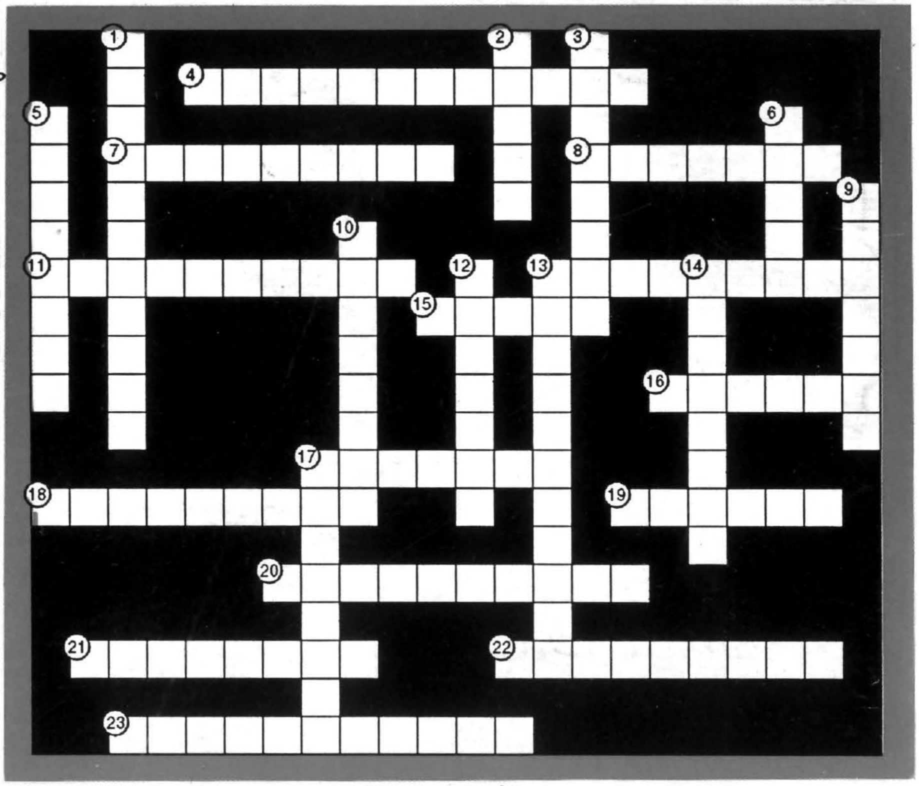
Other activities include working with industries, builders, homeowners and renters to prevent dumping and reduce pollution.

Fighting nonpoint source pollution is important because South San Francisco Bay is shallow. Water moves more slowly here than in other parts of the Bay. This is one reason why the Santa Clara Valley is among the first areas in the United States to launch a fight against nonpoint source pollution.

The Santa Clara Nonpoint Source Pollution Control Program is serving as an example to other parts of the country.

Nonpoint Source Pollution
Crossword Puzzle





ACROSS

4. Process of removing impurities from water.
7. Impurities that make water unusable for living things.
8. First stage of wastewater treatment.
11. Product used in the garden to aid plant growth.
13. Involving non-living matter, like minerals and salts.
15. Pollution coming from a specific place; ____________ SOURCE POLLUTION.
16. Heavy metal.
17. Involving living or dead plant or animal material.
18. Wastewater treatment stage between primary and tertiary.
19. Rainfall and other water which flows over the land and into streams, lakes and San Francisco Bay.
20. Water that carries people's pollutants.
21. Very small organisms which often cause disease.
22. Process used to clean wastewater; WASTEWATER ________________.
23. Metals, such as lead and zinc, which can harm fish life; 2 words.

DOWN

1. Shorebird of San Francisco Bay which is an endangered species; 2 words.
2. Water from rains which run off the land, carrying pollutants; ________ WATER.
3. Water pollution caused by a variety of sources; ______ SOURCE POLLUTION.
5. Place used to dispose of solid waste; dump.
6. Pipe used to carry off storm water; STORM ____________.
9. Manufacturing plant which can be a source of point source pollution.
10. Third stage of wastewater treatment.
12. Liquid used to remove stains by dissolving them.
13. Large pipe used to carry wastewater to a treatment plant.
14. Fuel which can become a nonpoint source pollutant.
17. Any living thing.

From Rain to Drain

Water for the Santa Clara Valley

TEACHER'S GUIDE

Presented by The Santa Clara Valley Water District and
The Santa Clara Valley Nonpoint Source Pollution Control Program

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Introduction

Rain to Drain —Water for Santa Clara Valley and its **Teacher's Guide** have been designed as part of the Santa Clara Valley Water District's water conservation program. Established in 1976, this effort has brought the District's message of wise water use to thousands of students. The student book and teacher's guide were first developed in 1986 and revised in 1992 to accomplish a variety of tasks—most importantly, to provide a foundation of basic water education with emphasis on conservation. **Rain to Drain—Water for Santa Clara Valley** achieves this goal through a series of water-related lessons, each of which has potential activities in a variety of curricular areas.

To help you in this task, the teacher's guide offers two implementation formats, allowing you, the teacher, to choose the instructional plan that's best for you. Specific lesson plans include curricular concepts, instructional objectives, step-by-step procedures and bonus spin-off suggestions which add to the flexibility of the materials, as well as answers to the student book activities. **Note:** Many of the Bonus Activities are non-science in their curricular orientation, thus making the unit more multidisciplinary.

Implementation

The student book activities are to be used in one of two implementation formats described below—either as a series of water-related activities selected by the teacher and infused into the curriculum, or in a discrete unit on water.

INFUSION: In the first implementation option, the individual teacher selects student book activities which best fit his/her prevailing setting. Since specific educational objectives are stated for each activity, this approach enables teachers to select the lessons which help fulfill the goals for their grade level, such as those set forth in the **Science Framework for California Public Schools.** Each activity has been designed to stand alone, allowing students to achieve the objectives without relying on any other student book exercise for its successful completion. Therefore, by building in this flexibility of choice, **Rain to Drain—Water for Santa Clara Valley** can serve in any situation, whether by the selection of individual lessons which meet particular instructional needs or through modification of the suggested unit.

WATER UNIT: This suggested unit features specific lessons which have been designed to achieve a combination of water objectives. The sequence introduces the student to the topic of water, explores its physical properties, investigates its uses, examines its treatment and distribution, underscores its value, stresses the need for its conservation, and discusses the problems of water pollution, both natural and created, from point and nonpoint sources, as well as pollution control and prevention. The outline presented below can serve as a guide for this unit approach.

Unit Outline

Day	Lesson	Student Activities	Lesson Notes
1	Unit Introduction	Unit Pretest, Teacher's Guide, p. 18 Videotape, "Water: Too Little and Too Much" "Water Glossary," Teacher's Guide, pp. 22–23	p. 4
2	**Lesson 1:** Basic Water	"Forms of Water" reading, Student Book, p. 2 "Water Cycle" reading, Student Book, p. 3 "Basic Water" experiment, Teacher's Guide, p. 5	p. 5
3	**Lesson 2:** Sources of Our Water	"Sources of Our Water" reading, Student Book, pp. 4–5 "Fix the Map" activity, Student Book, p. 5	p. 6
4	**Lesson 3:** Groundwater and Water Treatment	"Water from Underground" reading, Student Book, p. 6 "Water Treatment" reading, Student Book, p. 7 "Water Treatment" experiment, Student Book, p. 7	pp. 7–8
5	**Lesson 4:** Water in Use and Water Supply Problems	"Water in Use" reading, Student Book, p. 8 "What's An Acre Foot?" activity, Teacher's Guide, p. 9 "Too Much Water" reading, Student Book, p. 9 "Too Little Water" reading, Student Book, p. 10 "Subsidence" reading, Student Book, p. 11 "Sinking Feeling" activity, Student Book, pp. 10–11	pp. 9–10

Unit Outline... *continued*

Day	Lesson	Student Activities	Lesson Notes
6	**Lesson 5:** Water Conservation	"What Happens If We Run Short?" activity, Student Book, p. 12 "How Low Can You Go?" activity, Student Book, p. 13 "A Million and Eight Ways to Save Water" reading, Student Book, pp. 14–15	p. 11
7	**Lesson 6:** Introduction to Water Quality and Point Source Pollution and Treatment	"Water Quality" reading, Student Book, p. 16 "Point Source Pollution" reading, Student Book p. 17 "How They Clean Up Wastewater" reading, Student Book, p. 17 "Nonpoint Source Pollution Checklist" activity, Student Book, p. 18	pp. 12–13
8	**Lesson 7:** Nonpoint Source Pollution	"Nonpoint Source Pollution" reading, Student Book, p. 19 "What's the Problem?" reading, Student Book, p. 20 "Nonpoint Source Pollution Maze" activity, Student Book, p. 21	pp. 14–15
9	**Lesson 8:** Nonpoint Source Pollution Control and Prevention	"Nonpoint Source Pollution...What to Do About It" reading, Student Book, pp. 22-23 "What Else is Happening?" reading, Student Book, p. 23 "Nonpoint Source Pollution Crossword Puzzle" activity, Student Book, p. 24 Unit posttest, Teacher's Guide, p. 19	pp. 16-17

Pre-teaching Activity

The videotape **Water: Too Little and Too Much** is available at the Santa Clara Valley Water District. It is probably best used as an introduction to a water unit, although it certainly can be shown on its own, or as a culminating activity to a study of water. The following Pre-teaching Activity has been designed to accomplish this introductory task.

1. Introduce the unit by administering the unit pretest. An answer key is provided on page 21 of this guide.
2. Continue the activity by explaining to the students that they are about to spend a few days studying about water—where it comes from, how we get it, what we do to make it usable, how we use it and how we must protect it and use it wisely.
3. Show the videotape, "Water: Too Little and Too Much."
4. Discuss the tape; ascertain the level of class water awareness.
5. Hand out the "Water Glossary" and explain its significance for new vocabulary. (See "Repro #1—Water Glossary" provided on pages 22–23 of this guide.)

Lesson 1: Basic Water

STUDENT BOOK: Pages 2-3, "Forms of Water" and "Water Cycle"

OBJECTIVES: The student will be able to:

1. **Name** the three forms of water.
2. **Explain** how water changes from one form to another.
3. **Differentiate** between the various conditions of water in any given form.
4. **Identify** the various stages of the water cycle.
5. **Describe** how the water cycle works.
6. **Predict** changes in the weather, based on knowledge of the water cycle.

CONCEPTS:

Earth Sciences

B-3 What is the history of the earth, and how have geomorphic processes shaped the earth's present features?

C-1 What is the water cycle? How does the water cycle affect the climate, weather, and life of the earth? How does water affect surface features of the land and the ocean floor?

D-1 What are the physical bases of the earth's climate and weather?

D-2 What are the major phenomena of climate and weather? What are the large- and small-scale causes of climate and weather?

INTRODUCTION: Most students know that water exists in three forms. This lesson begins with a review of these forms and moves on to an investigation of what causes the changes between forms and the varied conditions within any given form. The "Forms of Water" reading, page 2 of the **Student Book**, initiates this investigation.

One of the important concepts to teach students about resources is the difference between renewable and nonrenewable. Nothing emphasizes the renewable nature of water better than the water cycle. The reading, "Water Cycle," provided on page 3, describes this process. By learning how water moves through the environment, constantly replenishing itself in recoverable forms and varied places, students will understand the unique benefits of a renewable resource. Hence, not only does this lesson teach the process of the water cycle, but it also establishes water as a resource of restoring value.

PROCEDURES:

1. Begin the lesson by having the students read "Forms of Water" and "Water Cycle," pages 2–3.
2. When the students have completed the reading, review the concepts presented in the readings. Make sure that the class understands the differences between the forms of water, as well as the various stages of the water cycle and how water moves from one phase to another.
3. To test their comprehension, have the students, working in small groups, conduct the following experiment:
   a. Make several ice cubes, using an ice tray with individual cube compartments and by placing an identical amount of water in each compartment. (**Note:** To expedite the lesson, you may want to prepare the ice cubes the night before and simply explain to the class what you did to make them.)
   b. Provide the students with the temperature of the freezer and have them hypothesize how long it will take the cubes to freeze solidly.
   c. Once you have several cubes, proceed to measure the melting and evaporation rates of ice and water. Make sure that the students continue to hypothesize on the results, plus observe the changes and then use the observation data to prove or disprove their theories. You might try any of the following tests:
      1) How long does it take a cube to melt, using a hair dryer (note the temperature of the hot air) vs. out in the sun (note the surface temperature)?
      2) How long does it take for a cube to melt in the shade vs. in the sun?
      3) How long does it take water (use same amount as in each ice cube) to evaporate, using a hair dryer vs. out in the sun vs. in the shade?
      4) How long does it take water to evaporate in the sun or shade with little air movement vs. blowing air across the water with a fan?
      5) Let the students determine other variables to test.
4. Following the experiments, discuss the findings. Ask what these tests tell us about how water changes form naturally. Note how we change water's form to suit our needs, e.g. making ice cubes for cold drinks, using a vaporizer to clear a stuffy nose, deicing airplane wings for safe flights, running a dehumidifier for comfort in a tropical climate, etc.
5. Continue the lesson by discussing how water differs while still in the same form. For example, the difference between ice, snow, hail, sleet, etc.—all solid forms of water. Or the difference between rain, clouds, steam—all liquid forms of water. Note the factors which determine these variations and how the form change is accomplished.
6. Shift the focus of the discussion to how the water cycle manifests itself in weather. Note the clues which forewarn us of weather changes and allow us to predict and plan those changes, e.g., a drop in temperature or the appearance of clouds. Ask what clues are present today which might help us predict tomorrow's weather.
7. Conclude the lesson by asking the students to write a water cycle diary over the next three days, noting evidence of the water cycle at work around them.

BONUS ACTIVITIES:

- Have the students draw a scene depicting water in as many different forms as possible.
- Using "Water Form" words, have the students demonstrate the creation of compound words or changing verb tenses.
- Have the students write a poem or song about the water cycle or the weather.
- Have the students see how many words they can make out of the letters in EVAPORATION.
- Have the students draw a schematic of the water cycle on the chalkboard, using different topography and bodies of water than the example illustrated in the **Student Book**.
- Have the students build a rain gauge. This could then be placed on the campus and used for daily recording over an extended period of time.
- Conduct a study of clouds—the various types and how the presence of certain cloud types aids us in predicting the weather.

Lesson 2: Sources of Our Water

STUDENT BOOK: Pages 4-5, "Sources of Our Water" and "Fix the Map" activity

OBJECTIVES: The student will be able to:

1. **List** the major sources of water supply for Santa Clara County.
2. **Locate** on a map of Northern California the major sources of his/her local water supply.
3. **Contrast** the advantages and disadvantages of using local versus imported water supplies.

CONCEPTS:

Earth Sciences

B-3 What is the history of the earth, and how have geomorphic processes shaped the earth's present features?

C-1 What is the water cycle? How does the water cycle affect the climate, weather, and life of the earth? How does water affect surface features of the land and the ocean floor?

D-1 What are the physical bases of the earth's climate and weather?

INTRODUCTION: Santa Clara County is supplied its water from far and wide. Roughly one-half is imported from Northern California rivers. This water comes to the county via the San Felipe Project, the State Water Project, and the Hetch-Hetchy system. San Felipe is a federal government source, which includes the Trinity River, Lake Shasta, Sacramento River, Sacramento-San Joaquin Delta, California Aqueduct and San Luis Reservoir. The State Water Project includes the Feather River, Lake Oroville, Sacramento River, the Delta and the South Bay Aqueduct. Hetch-Hetchy, owned and operated by the City and County of San Francisco, includes the Tuolumne River, Hetch-Hetchy and Don Pedro Reservoirs, and the Hetch-Hetchy Aqueduct. Some of the state and federal water (but none of the Hetch-Hetchy water) is percolated into the water table, later to be pumped from wells throughout the county.

The other 50% of the county's water supply is groundwater. Much (40%) of the groundwater is supplied by natural recharge through creeks. But most (60%) of the underground water finds its way to aquifers as a result of artificial groundwater recharge. Rainwater captured in local reservoirs is released down creeks throughout the year (except during and after heavy storms when creeks are full). Water percolates through the gravel and sands in the creeks and also in off-stream groundwater recharge ponds adjacent to the creeks. As aquifers are refilled by this process, there is more water available to wells, which pump out the water for use by homes, industry and farms.

"Sources of Our Water," provided on pages 4–5 of the **Student Book**, presents this information in a clear and concise manner. The activity, "Fix the Map," emphasizes some local geography as the students unscramble the names of local towns, cities and reservoirs.

PROCEDURES:

1. Begin the lesson by asking the students where they think their water comes from. Relate the discussion to the concepts presented in the water supply activity.
2. Continue the lesson by having the class read "Sources of Our Water" on pages 4–5.
3. Once the students have completed the reading, assign the "Fix the Map" activity, found on page 5.

"Fix the Map" Answer Key

MEDLAAN — Almaden
NSA SOEJ — San Jose
LMISAPIT — Milpitas
PEADUUGAL — Guadalupe
LOPA LOTA — Palo Alto
PLEBACML — Campbell
NAVASO — Vasona
GORMNA LIHL — Morgan Hill
OOYCTE — Coyote
NUSVLENYA — Sunnyvale

4. Have the students correct each other's work.
5. Using a wall map of the state, locate the major elements of the state's water systems, including those mountains, rivers, lakes, reservoirs, canals and aqueducts cited in the Introduction.
6. Next, continuing to use the wall map, and referring to the various steps in the water cycle, trace the possible paths of water from snow in the Central Sierras and rain falling north of Redding.
7. Conclude the lesson by having the students list the advantages and disadvantages of using local versus imported water supplies.

BONUS ACTIVITIES:

- Arrange for a tour of Santa Clara Valley Water District facilities, (408) 265-2600.
- Have the students alphabetize the water vocabulary words found in each reading assignment.
- Have the students write a summary paragraph in which they trace water from the Northern California mountains to their homes.

Lesson 3: Groundwater and Water Treatment

STUDENT BOOK: Pages 6–7, "Water from Underground" and "Water Treatment" with "Experiment"

OBJECTIVES: The student will be able to:

1. **Define** pollution of surface and groundwater.
2. **Locate** on a map the major water treatment and distribution facilities in Santa Clara County.
3. **Describe** the process of water percolation.
4. **Enumerate** the benefits of water percolation as it relates to Santa Clara County's water supplies.
5. **Explain** the need for water treatment.
6. **Recognize** the various steps involved in water treatment and distribution.

CONCEPTS:

Earth Sciences

B-3 What is the history of the earth, and how have geomorphic processes shaped the earth's present features?

C-1 What is the water cycle? How does the water cycle affect the climate, weather, and life of the earth? How does water affect surface features of the land and the ocean floor?

D-1 What are the physical bases of the earth's climate and weather?

Life Sciences

C-3 How do ecosystems change?

INTRODUCTION: Groundwater is an important concept to understand when studying water supply in Santa Clara County. Without this phenomenon, the entire water supply and distribution picture would be quite different. But by using this natural system, imported water can be cleaned, stored and distributed in an efficient and economical manner.

Percolation of groundwater plays a major role in purifying water by removing suspended solids and killing bacteria. As water seeps down to aquifers, solids are left behind in the sand, soil and rock; and bacteria die because they cannot survive in the underground environment. Groundwater basins act as huge storage reservoirs. Furthermore, the lateral movement of this groundwater acts as a natural distribution system, delivering water from the point of percolation to communities throughout the county where it can be recovered from wells.

The quality of surface water supplies is also important. Depending on its source, a supply may have natural pollution problems which require special treatment. Frequently, humans pollute water supplies, too. Surface water can be contaminated by runoff, illegal dumping and littering. Water agencies must then treat this water to insure its purity.

Santa Clara Valley Water District operates three drinking water treatment plants: one each in Los Gatos, East San Jose and Almaden Valley. These plants can provide up to 40 percent of all the water used in our valley. Water is disinfected, dirt and other impurities are removed, and a final disinfection occurs as the water leaves the plants for use by private water companies and city water departments.

Groundwater, also, can be affected by pollution. Toxic substances can reach an aquifer by seeping down through the soil. Such problems need to be solved at the source, since complete removal of contaminants from groundwater is nearly impossible.

The "Water from Underground" and "Water Treatment" readings, pages 6–7 of the **Student Book**, explain how Santa Clara County's water is percolated, treated and delivered to various towns and cities. The water treatment concepts are reinforced for the students in the "Experiment" activity.

PROCEDURES:

1. Begin the lesson by holding up a glass containing muddy water. Ask the students to describe the water. They will undoubtedly use such terms as: "muddy," "dirty," "yucky" and "polluted."
2. Help the students develop a definition of "pollution."
3. Continue the discussion by asking the class how water becomes polluted. Make sure that they understand how water becomes polluted. Make sure that they understand how pollution occurs naturally in the environment and how such pollution might affect a drinking water supply.
4. Using a wall map of Santa Clara County, point out major water supply and treatment facilities.
5. Ask the students to explain how water gets from the reservoirs and treatment plants to your community. After they have supplied their answers, confirm the fact that much of the water distribution in the Santa Clara Valley relies on groundwater and its movement through aquifers.
6. To explain how this natural distribution system works, as well as how drinking water is treated, assign the "Water from Underground" and "Water Treatment" readings on pages 6–7.
7. Once the students have completed the readings, discuss the material. Underscore the fact that water agencies use the natural process of percolation to aid in water treatment and distribution.
8. Follow the discussion with the "Experiment" provided on page 7 in the **Student Book**. Make sure that the students understand that the level of treatment is determined by the level of pollution in any given water supply.

"Experiment" Answer Key

4. The water will appear cloudy and dirty.
6. Although there still may be some cloudiness to the water, it will appear much clearer than before "treatment."
7. Note that the cotton-sand filtration acts very much like the charcoal-sand method used at treatment plants. However, the experiment does nothing to kill germs, as in disinfection, nor have clarification chemicals been added.

9. Follow up the experiment by dividing the class into three small groups and assign each one a step of water treatment, as described in the reading. Have each group devise a way of pantomiming their stage of treatment. Finally, call on each group to "act out" their step and then explain what they did and why their role is important in the treatment process.
10. Follow up the experiment by having the students write a short story of a water drop's trip from pollution through water

purification. Make sure that the students explain how the three stages of water treatment worked to clean them up.

11. Conclude the lesson by having the students trace the water distribution system used throughout the county.

BONUS ACTIVITIES:
- Create a bulletin board which illustrates the county's water treatment and/or distribution systems.
- Have the students write a quiz on water treatment and/or distribution. This might be done in pairs or in small groups. Use the best questions for an actual quiz.
- Take a tour of a water treatment plant.

LESSON NOTES

Lesson 4: Water In Use and Water Supply Problems

STUDENT BOOK: Pages 8–11, "Water in Use," "Too Much Water," "Too Little Water" and "Subsidence," with "Sinking Feeling" activity

OBJECTIVES: The student will be able to:
1. **Identify** and **define** the major water user groups in Santa Clara County.
2. **Explain** how each user group contributes to the quality of life in Santa Clara County.
3. **Compare** the advantages and disadvantages of each user group's consumption of water.
4. **Cite** several water problems of Santa Clara County.
5. **Relate** how each of these problems has evolved.
6. **Evaluate** how successfully each problem is being managed.
7. **Predict** the status of each problem in the next decade.

CONCEPTS:

Earth Sciences
B-3 What is the history of the earth, and how have geomorphic processes shaped the earth's present features?
B-4 What are the responsibilities of humans toward natural resources?
C-1 What is the water cycle? How does the water cycle affect the climate, weather, and life of the earth? How does water affect surface features of the land and the ocean floor?

Life Sciences
C-3 How do ecosystems change?
C-4 What are the responsibilities of humans toward ecosystems?

INTRODUCTION: "Water in Use," page 8 in the **Student Book**, examines the various water user groups found throughout the county. Each of these groups consumes a great deal of water in manufacturing products and providing services which directly or indirectly affect our quality of life. In fact, so much water is used in the county that its consumption is measured in acre feet. (An acre foot of water is an amount equal to the volume of one acre covered with water to a depth of one foot.) The students were introduced to this unit of measure in the book and then engaged in a math exercise, designed to illustrate the volume of water an acre-foot represents. The "Water in Use" activity and the following lesson then engage the class in an identification of these user groups, a survey of how each uses water and an evaluation of the advantages and disadvantages of their consumption as it relates to the county.

The Santa Clara Valley Water District not only brings water into the county and manages it through treatment and distribution, but it is also concerned with a variety of water problems. Four, in particular, are important to consider: water quality, floods, land subsidence and water shortages.

In addition to water quality, which is dealt with in a later lesson, flood control is a major responsibility of the Valley Water District. Seasonal rains often bring more runoff than local streams can handle. A variety of means are employed to direct this water through streams and channels to the Bay. These include "channelizing" stream beds to carry maximum flows during storms; building levees to keep water from overflowing stream banks; widening and deepening creeks, and creating flood plain areas where water can overflow without damaging property. People help prevent flooding by not putting trash into creeks which might impede the flow.

The problem of land subsidence also must be addressed. For over 50 years more water was taken out of the ground than was replaced. As the water was removed, the fine silts in clay layers were squeezed together. Having lost its buoyant support, the land sank. This overdrafting caused significant settling of the earth in many places—13 feet in downtown San Jose, for example. Obviously, if this occurs in a developed area, buildings and underground lines are seriously affected. However, by a program of recharging the groundwater with imported water, the Valley Water District was able to stop subsidence in 1969. It could reoccur during a long drought.

Finally, from time to time the county has been faced with serious water shortages. The Valley Water District has dealt with these occurrences by having sufficient groundwater storage to provide basic water service to all of its users for their essential needs. The District also maintains a vigorous water conservation program so that our water resources are always carefully respected, in times of plenty as well as times of drought.

PROCEDURES:

1. Begin the lesson by having the students list as many major water user groups as they can, e.g. residential (home, apartment, condominium), commercial (carwash, beauty shop, water slide, film processing plant, laundry), industrial (bottling plant, computer manufacturing plant, food processing plant, oil refinery), agricultural (livestock, poultry, dairy, vineyard, orchard, farm), institutional (park, fire fighting, hospital, military base, public swimming pool, golf course).

2. Assign the reading "Water in Use" on page 8. Have the students pay particular attention to how each group uses the water and how much each consumes.

3. Discuss the reading, beginning with the concept of acre feet. To illustrate the volume of an acre foot, have the students calculate how many classrooms full of water are equal to an acre foot. To do this, you must first compute the number of cubic feet in your classroom and then divide that number into 43,560, the number of cubic feet in an acre foot. In other words, if your classroom is 30 feet long, 30 feet wide and 12 feet high, it holds 10,800 cubic feet of water. By dividing this figure into 43,560, you would discover that it would take a little less than four classrooms to hold an acre foot of water. You also might extend this math exercise by having the students calculate the number of gallons your classroom could hold. (Multiply your cubic feet by 7.481.)

4. Continue the lesson by returning to a review of the reading. Have the students note if and how some of the water consumption described could be reduced without significantly affecting the end product or service.

5. Assign the "Water in Use" activity, provided on page 8. Students should be able to think of many more examples of water use than they have room to record. Be sure that they remember all of the "ordinary" uses of water in such settings as a firehouse or a car wash, e.g. washing hands, landscape watering, etc.

6. When the students have completed the activity, discuss their answers.
7. Shift the focus of the lesson to the subject of water problems which affect the Valley.
8. Assign the "Too Much Water," "Too Little Water" and "Subsidence" readings, pages 9–11 in the **Student Book**.
9. Continue the lesson by assigning the "Sinking Feeling" activity, pages 10–11 in the **Student Book**. Answers to the activity are as follows:

"Sinking Feeling" Answer Key

In discussing this activity, make sure to contrast what happened in the demonstration with real life conditions. Obviously, subsidence does not happen overnight and the results are not as immediately apparent. And since the real action is much slower, remedial steps, such as recharging the groundwater, can serve to limit, if not halt, the damage. But it also should be mentioned that settlement of just a few inches can cause serious consequences, e.g. broken utility lines (water, gas, electricity) and structural damage to buildings, roads, etc.

10. After the students have finished the reading, discuss each of the problems.
11. Continue the lesson by asking the students to relate personal experiences with these problems, e.g., getting flood water in their homes or going through water rationing during periods of drought.
12. Next, have the students, individually or in small groups, write a newspaper headline and the first two paragraphs of a news article on an incident related to one of the water supply problems discussed. Encourage them to use local place names and, although the events described might be exaggerated, the technical content should be accurate.
13. Conclude the lesson by examining what water agencies and other public and private bodies are doing to correct the problems and what, if anything, individuals can do. Note which, if any, of these problems can be solved permanently and which appear to be ongoing concerns.

BONUS ACTIVITIES:

- Have the students write a letter to a politician expressing concern about water problem, what the students plan to do about it and what they want the addressee to do.
- Clip articles out of the newspaper or magazines which deal with water problems.
- Have the students make a bulletin board on water problems.
- Have the students write a summary paragraph on water use by one or more of the user groups discussed.
- Have the students research how people solved such problems as water shortages and floods 100 years ago in the Santa Clara Valley.
- Invite a speaker from a major water user group to describe how his/her organization uses water. Have him/her note any conservation measures that have been adopted, and when and why they were instituted. You might even consider inviting speakers from several different groups to appear on a panel and address the same points.
- Have the students solve the "Santa Clara Valley Hidden Water Names" puzzle. This activity is provided on "Repro #2—Santa Clara Valley Hidden Water Names" on page 24 of this guide. Answers to the puzzle are found on page 20.

LESSON NOTES

Lesson 5: Water Conservation

STUDENT BOOK: Pages 12–15, "What Happens If We Run Short?" and "How Low Can You Go?" activities, and "A Million and Eight Ways to Save Water"

OBJECTIVES: The student will be able to:
1. **List** several ways in which water is wasted in the home.
2. **Rank** these water waste practices in order of magnitude.
3. **Relate** at least one water conservation practice to each water waste practice.
4. **Demonstrate** the effectiveness of a water conservation practice.

CONCEPTS:

Earth Sciences

B-4 What are the responsibilities of humans toward natural resources?

Life Sciences

C-1 What are ecosystems, and how do organisms interact in ecosystems?

C-4 What are the responsibilities of humans toward ecosystems?

INTRODUCTION: Nothing compares with conservation when it comes to something everyone can do to help solve a water problem. Saving water can be done at home, at school, in the office and factory...everywhere. "What Happens If We Run Short?" page 12 of the **Student Book**, dramatically brings the problem of water shortage home to the students. The "How Low Can You Go?" activity actually gets them to examine their own everyday water use practices and how much of the resource they might save through water conservation practices. "A Million and Eight Ways to Save Water," pages 14–15, presents additional water-saving ideas for application at home and on the school campus.

PROCEDURES:

1. Begin the lesson by having the students read "What Happens If We Run Short?" page 12 in the **Student Book**.
2. Once the students have finished the reading, discuss their answers and ask them for some additional examples of the effects of severe drought. Have they observed any of these conditions in the past few years?
3. Continue the lesson by asking the students how water is wasted—at home—at school. Make two lists on the chalkboard for their responses.
4. Next, ask the students to suggest water-saving techniques to correspond with each of the water-waste actions listed on the board. Have the students rank the water-saving tips in order of magnitude.
5. Assign the "How Low Can You Go?" activity, page 13. Read it over in class with the students and discuss what they are to do.
6. Correct the student answers when the class has completed the exercise.
7. Have the class read "A Million and Eight Ways to Save Water," pages 14–15.
8. When the students have finished the reading, discuss the material. Add any additional conservation tips to the list on the chalkboard.
9. Have the students demonstrate the effectiveness of a water conservation practice through a physical demonstration, a pantomime or a skit.
10. Conclude the lesson by having the students design a generic home water conservation program. It should be appropriate for use in either a house or an apartment, and must include both repair and maintenance suggestions for the plumbing, as well as behavioral changes for the inhabitants.

BONUS ACTIVITIES

- Have the students conduct a water conservation audit of their homes, identifying areas where water could be saved. Of course, the audit should be followed up with the implementation of corrective conservation measures.
- Have the students write a letter to someone, encouraging them to practice water conservation.
- Conduct a lesson on basic home plumbing. Be sure to include how to change a washer. If you feel uncomfortable with the subject, invite a plumber, a handyperson or the school custodian to do the presentation.
- Have the students solve the "Water Crossword" puzzle. This activity is provided on "Repro #3—Water Crossword" on page 25 of this guide. Answers to the puzzle are found on page 20.

Lesson 6: Introduction to Water Quality and Point Source Pollution and Treatment

STUDENT BOOK: Pages 16–18, "Water Quality," "Point Source Pollution," "How They Clean Up Wastewater" and "Nonpoint Source Pollution Checklist" activity

OBJECTIVES: The student will be able to:

1. **Define** pollution and **identify** areas of the environment which may become polluted.
2. **Describe** how natural water purification takes place.
3. **Explain** how human interaction with the environment can overload the ecosystem and exceed its ability to cleanse itself.
4. **Differentiate** between point and nonpoint source pollution.
5. **Identify** point sources of pollution.
6. **Explain** how water treatment corrects point source pollution problems.
7. **Assess** his/her own home as a cause of nonpoint source pollution problems through the use of an audit.

CONCEPTS:

Physical Sciences

A-3 What principles govern the interactions of matter? How does chemical structure determine the physical properties of matter?

Earth Sciences

B-4 What are the responsibilities of humans toward natural resources?

C-1 What is the water cycle? How does the water cycle affect the climate, weather, and life of the earth? How does water affect surface features of the land and the ocean floor?

C-4 How do humans interact with the oceans? What may be some long-term effects of human interaction with the oceanic environment?

D-1 What are the physical bases of the earth's climate and weather?

Life Sciences

C-1 What are ecosystems, and how do organisms interact in ecosystems?

C-3 How do ecosystems change?

C-4 What are the responsibilities of humans toward ecosystems?

INTRODUCTION: This lesson begins with an introduction to the subject of water pollution. "Water Quality," page 16 in the **Student Book**, reviews how pollution occurs naturally in the environment. The material points out that natural pollution comes from organic sources, e.g. dead plant and animal matter, which use oxygen and create gasses and chemical compounds that lower water quality. The students also learn about natural inorganic pollution, caused by water picking up certain kinds of mineral deposits, such as copper, which can be poisonous to some fish and plants.

The reading goes on to explain that water also is naturally purified of organic and inorganic contamination. The important concept to stress at this point is that human intervention into the natural setting can produce pollution which exceeds the ecosystem's ability to clean itself, thus causing a pollution problem. Such pollution can originate from point and nonpoint sources.

The next reading, "Point Source Pollution," page 17, defines point source pollution and describes its composition. This type of pollution is caused by contamination of water from a specific source, such as a factory. Water quality laws now require such dischargers to "pretreat" their wastewater before they send it to a water treatment plant through the sanitary sewer. Industry needs a special permit to discharge directly to surface water, and the permit generally requires a high level of treatment at the facility.

In our area, nearly all of the wastewater from industry, businesses and homes flows through the sewers to a sewage treatment plant. The exception is residents in outlying areas who are not connected to city sewer systems and store their waste in septic tanks. The treatment plant provides one, two or three stages of treatment—three is best. Following treatment, the water is released into a water body, such as San Francisco Bay. Problems associated with releasing treated wastewater in our area arise when people put substances in the sewers that treatment plants cannot remove with existing technology. Metals (lead, nickel, zinc, copper and silver) are of special concern in south San Francisco Bay. "How They Clean Up Wastewater," also on page 17, explains the wastewater treatment process.

The final segment of this lesson, the "Nonpoint Source Pollution Checklist," page 18, engages the students in an examination of their own homes for nonpoint sources of pollution. Nonpoint source pollution cannot be traced to a single point of origin. It occurs when stormwater runoff flows over the ground, picking up all sorts of pollutants.

The student activity not only personalizes the material so that the students take a more direct interest in the subject, but it serves as an introduction to a serious problem which is of growing concern to the Santa Clara Valley.

PROCEDURES:

1. Introduce the day's lesson by asking the students to define "pollution." Refine their suggested definitions until class consensus is reached and write the end result on the chalkboard.
2. Ask the students to identify the areas of the environment which may become polluted—air, land, water. Have the students cite examples of how air, land and water can become polluted, both naturally and by human actions.
3. Explain to the class that they are going to examine one aspect of water pollution which is of great concern to their own area, the South San Francisco Bay area.
4. Assign pages 16–17 in the **Student Book** for reading.
5. When the class has completed the reading assignment, discuss the material and answer any remaining student questions.
6. To test their knowledge of point and nonpoint sources of water pollution, ask the students to list water uses in the home and to identify how these various uses might result in point and nonpoint source pollution problems. Have them identify where the water goes after it has been used. Write their responses on the chalkboard and identify which problems are point and which are nonpoint. Ask how else pollutants might get into storm drains.

7. Conclude the lesson by assigning the "Nonpoint Source Pollution Checklist," found on page 18 in the **Student Book**. Encourage the students to enlist the aid of their parents in completing this survey. Inform the class that the audit will be discussed at the beginning of class tomorrow.

BONUS ACTIVITIES:

- Have the students construct a diorama illustrating how point and nonpoint source pollution impacts the land, streams and receiving waters.
- Have the students clip newspaper and magazine articles about water pollution, noting whether the incident is a case of point or nonpoint source pollution.
- Take a field trip to a water pollution control plant.

LESSON NOTES

Lesson 7: Nonpoint Source Pollution

STUDENT BOOK: Pages 19–21, "Nonpoint Source Pollution," "What's the Problem?" and "Nonpoint Source Pollution Maze" activity

OBJECTIVES: The student will be able to:

1. **Define** nonpoint source pollution and **identify** the various constituents comprising nonpoint source pollution.
2. **Trace** the route of one component of nonpoint source pollution from its origin to a receiving water.
3. **Observe** how nonpoint source pollution enters the ground via stormwater in a class experiment.
4. **Hypothesize** how nonpoint source pollution affects plants.
5. **Observe** the effects of nonpoint source pollution on plants in a class experiment.
6. **Demonstrate** an understanding of the path of nonpoint source pollution from its origin to a receiving water by completing a maze.
7. **Identify** specific problems caused by nonpoint source pollution.

CONCEPTS:

Physical Sciences

A-3 What principles govern the interactions of matter? How does chemical structure determine the physical properties of matter?

Earth Sciences

C-1 What is the water cycle? How does the water cycle affect the climate, weather, and life of the earth? How does water affect surface features of the land and the ocean floor?

C-4 How do humans interact with the oceans? What may be some long-term effects of human interaction with the oceanic environment?

D-1 What are the physical bases of the earth's climate and weather?

Life Sciences

C-1 What are ecosystems, and how do organisms interact in ecosystems?

C-3 How do ecosystems change?

C-4 What are the responsibilities of humans toward ecosystems?

INTRODUCTION: This lesson investigates the causes, composition and effects of nonpoint source pollution. The students begin this study by examining the results of their home surveys, noting how their personal behaviors can result in environmental damage unless proper disposal techniques are employed. The reading assignment, "Nonpoint Source Pollution" and "What's the Problem?" pages 19-20 in the **Student Book**, describe how society has created a major threat to receiving waters by careless and ignorant behaviors in disposing of our wastes.

Nonpoint source pollution is composed of a wide array of contaminants. These include oils and greases, metals, cleaning solvents, garden chemicals, soil and organic wastes. Nonpoint source pollutants get washed off of soil and pavement, into gutters and storm drains until they finally get into a stream and then San Francisco Bay.

The lesson continues with a class experiment which demonstrates how stormwater transports pollutants which we can't control—like metals, oil, gasoline and particulate from automobile exhaust that collect on roadways and wash to the storm drains—and how these pollutants affect ecosystems from the ground at the point of origin to nearby streams to the ultimate receiving waters. Finally, the students demonstrate their comprehension of the lesson by completing a maze, page 21, featuring the paths of nonpoint source pollutants, including heavy metals, petroleum products, chemical products, biological contaminants and soil erosion.

PROCEDURES:

1. Begin the lesson by briefly reviewing yesterday's material. Answer any student questions.

2. Discuss the results of the "Nonpoint Source Pollution Checklist." Since the survey covers material which could be viewed as personal and/or sensitive, avoid "putting the students on the spot" by requiring them to reveal information they prefer not to discuss. However, questions may be phrased to solicit volunteer responses, e.g., "Who would like to tell us what they found on Question #______?" or "Did anyone find some surprising answers to any questions?" The important outcome of this discussion is the realization that all homes contain nonpoint source pollutants which may be harmful to the environment unless their disposal is done properly. Ask the students to begin thinking about how nonpoint source pollution problems could be eliminated from their homes. Suggest that they discuss possible solutions with their parents.

3. Assign pages 19–20 in the **Student Book** for reading.

4. When the students have finished the reading, discuss the material and answer any student questions.

5. Continue the discussion by listing the five areas of nonpoint source pollution (heavy metals, petroleum products, chemical products, biological contaminants and soil erosion) on the chalkboard, and having the students cite examples of each found in their home audits. Ask the class to consider how each of these examples of nonpoint source pollution might be prevented.

6. To demonstrate the effects of nonpoint source pollution, conduct the following class experiment.

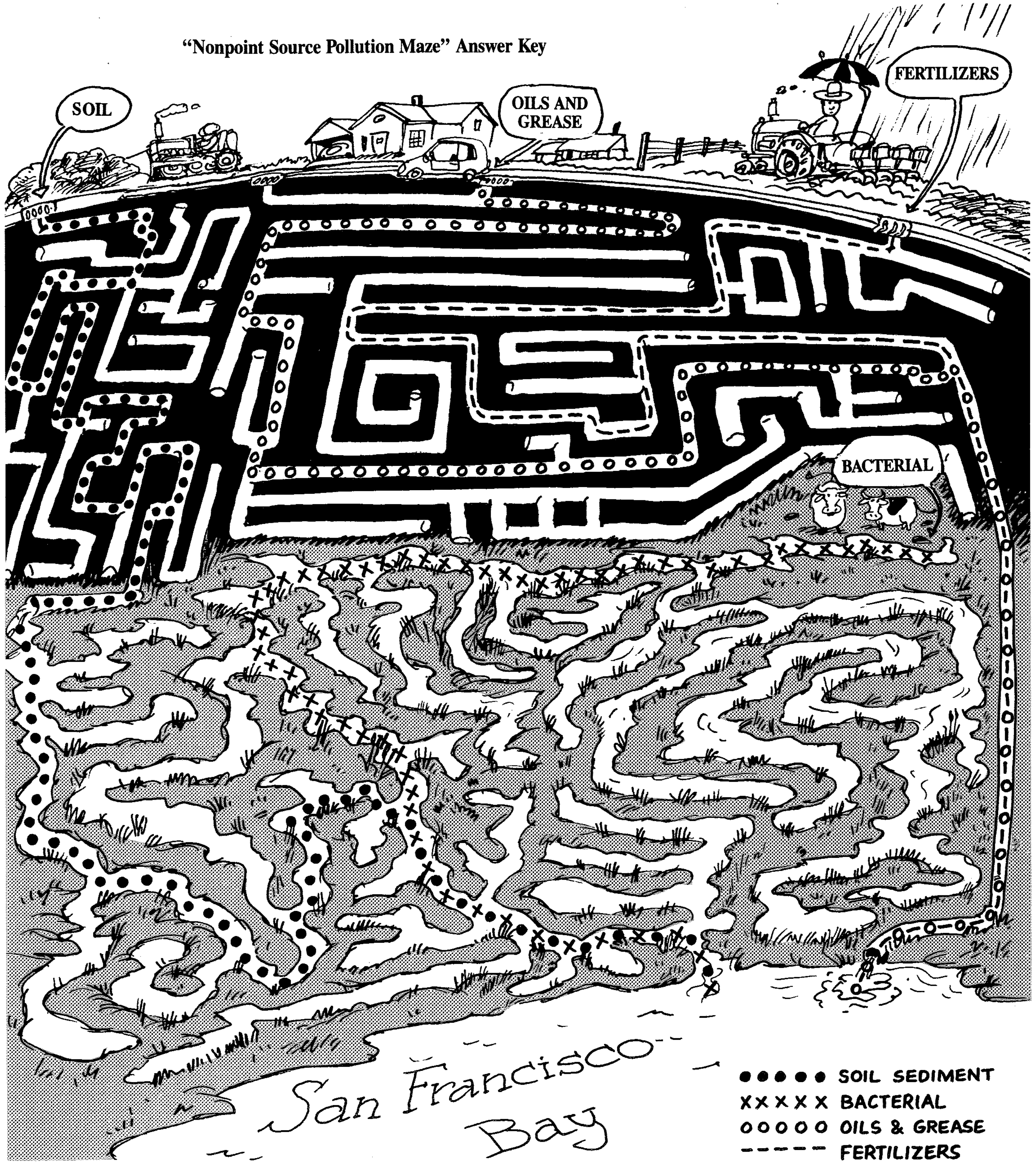
   (This experiment will involve pouring several examples of nonpoint source pollutants, such as paint, grease and pesticides, on separate dirt plots in shoe boxes, and then running water through them. The resulting wastewaters will be collected and observed by the students and then poured on plants, while clean water will be poured on a similar "control" plant. The students will be asked to hypothesize the effects of the samples on the plants and then follow up with weekly observations over the next month. By conducting the observations over a month, the residual unit learning will be extended.)

7. When the experiment is finished, conclude the lesson by assigning the student activity found on page 21 of the **Student Book**. An answer key is provided below.

BONUS ACTIVITIES

- Interview a service station owner to find out what happens to old oil, other lubricants and batteries.
- Design a nonpoint source pollution questionnaire to be used in surveying a business on its disposal procedures for hazardous wastes.
- Invite a representative from an appropriate agency to speak to the class on nonpoint source pollution.

"Nonpoint Source Pollution Maze" Answer Key



Lesson 8: Nonpoint Source Pollution Control and Prevention

STUDENT BOOK: Pages 22–24, "Nonpoint Source Pollution...What to Do About It" and "What Else Is Happening?" and "Nonpoint Source Pollution Crossword Puzzle" activity

OBJECTIVES: The student will be able to:

1. **Explain** how education and public information can help in controlling and preventing nonpoint source pollution problems.
2. **Describe** how regulation, along with inspection, detection and enforcement can control and prevent nonpoint source pollution.
3. **Cite** how the efforts of public agencies through planning and the construction and operation of new facilities can control and prevent nonpoint source pollution.
4. **Plan** a program of nonpoint source pollution control and prevention for his/her home.
5. **Design** a poster or write a public service announcement on the importance of controlling and preventing nonpoint source pollution.
6. **Demonstrate** comprehension of the unit's material by completing a nonpoint source pollution crossword puzzle.

CONCEPTS:

Physical Sciences

A-3 What principles govern the interactions of matter? How does chemical structure determine the physical properties of matter?

Earth Sciences

C-4 How do humans interact with the oceans? What may be some long-term effects of human interaction with the oceanic environment?

Life Sciences

C-3 How do ecosystems change?

C-4 What are the responsibilities of humans toward ecosystems?

INTRODUCTION: This culminating lesson of the unit presents an examination of solutions to the nonpoint source pollution problem. On a personal level, the lesson asks the students to combat the problem in their own homes by devising mechanisms of household nonpoint source pollution control and prevention. Suggestions for behavioral changes are provided for the students and their families relating to vehicles, homes and gardens.

In addition to changing behaviors, public agencies are developing new regulations for controlling and preventing nonpoint source pollution, covered in the reading on pages 22–23 in the **Student Book**. These measures include requirements that forbid companies from adding pollutants to the storm drain system. Other programs involve litter control, trash removal, street sweeping, storm drain cleaning, and regulation of industries, such as auto repair and building construction, whose activities often contribute to stormwater pollution.

The students also have the opportunity to effect change on the community level by creating a publc education message with a poster or public service announcement. Finally, the lesson concludes with a review of the nonpoint source pollution material, using a crossword puzzle, page 24.

PROCEDURES:

1. Initiate the unit's culminating lesson by reviewing yesterday's material and answering any student questions.
2. Go over the students' answers to the maze activity. As they discuss their conclusions regarding the paths of nonpoint source pollutants, ask them what other "non-scientific" problems might arise as a result of pollutants. For example, the cost of cleaning up a polluted stream will require tax money, or pollution in the Bay detracts from its recreational use.
3. Have the students read pages 22–23 in the **Student Book**.
4. When the class has completed the reading assignment, discuss the material and answer any remaining student questions. Have the students report on their plans to eliminate nonpoint source pollution problems from their homes. You might want them to refer again to their home audits at this point.
5. In order to give the students an opportunity to share their new-found knowledge of nonpoint source pollution with the community, divide the class into small groups of four to six students each.
6. Have each group design a poster which publicizes the nonpoint source pollution problem or offers a public education tip on how to help solve the problem. When the posters have been completed, try to get them displayed in prominent locations around the community, e.g., stores, banks, the public library and governmental offices. Or,

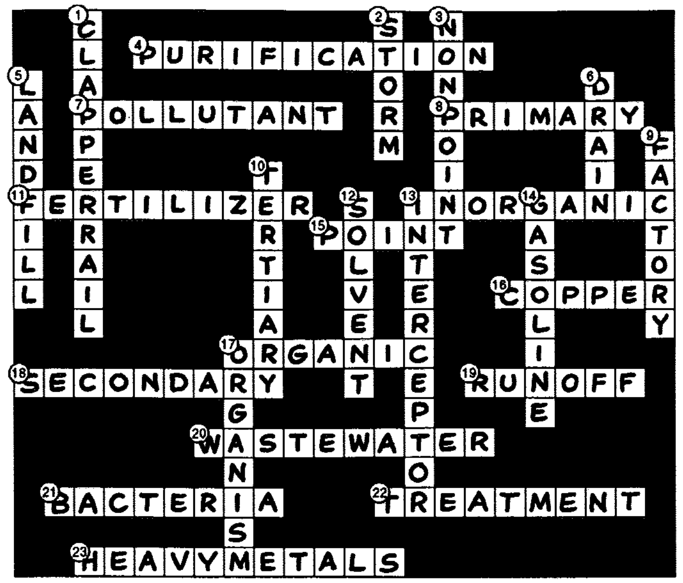
   Have each group write a thirty second public service announcement on the nonpoint source pollution problem and/or its solution. When the groups have finished writing their scripts, you might even have them record their efforts, using background music and sound effects, if appropriate.
7. Send the finished products to us at:

   Santa Clara Valley Water District
   Attn: Public Information Office
   5750 Almaden Expressway
   San Jose, CA 95118

   We'll get the word out.
8. To assess student comprehension of the unit's material, assign the crossword puzzle found on page 24 of the **Student Book**. You may choose to allow the students to use their unit glossaries for this activity.

9. When the students have completed the activity, discuss their results. An answer key follows:

"Nonpoint Source Pollution Crossword Puzzle"
Answer Key



10. Conclude the unit by administering the posttest. An answer key is provided on page 21 of this guide.

BONUS ACTIVITIES

- Design a one-page flyer on nonpoint source pollution and distribute it around the neighborhood.
- Create a display of household items which could cause nonpoint source pollution problems and write short descriptions of proper disposal techniques for each.
- Conduct a public information meeting for parents on the nonpoint source pollution problem and what can be done to solve it.
- Conduct an audit of the school campus for nonpoint source pollution problems and design a program to control and prevent these problems in the future.
- Invite a representative from an appropriate agency to speak to the class on what the agency is doing to solve the nonpoint source pollution problem.

LESSON NOTES

Rain To Drain—Water For The Santa Clara Valley Pretest

The following material describes the role of water in the Santa Clara Valley—its basic nature, sources of supply, treatment, use, conservation and quality. Read the material and see if you can identify the eight incorrect statements. When you find a sentence that is untrue, write the letter in front of the incorrect sentence on the back of this sheet of paper and then briefly explain why it is untrue.

A) Water is found in three forms, solid, liquid and vapor. **B)** Examples of these forms are: solid—ice, liquid—rain and vapor—steam. **C)** Water changes from one form to another as it moves through the water cycle. **D)** The cycle begins with evaporation when water falls to earth as rain, snow or hail. **E)** Once on the ground, it may run off into rivers, lakes and oceans. **F)** Or, it may percolate down into the ground to be used by plants or to collect in aquifers.

G) After using the water for growth, plants give some water back to the atmosphere in a process called chlorination. **H)** Other water goes back into the air from lakes and rivers by evaporation. **I)** Once in the air, the cycle can start all over again.

J) People use lots of water. **K)** We use it to drink, bathe, grow our food, play in and manufacture products. **L)** Sometimes we have to import water from a distant place to where we want to use it. **M)** To do this, we use pipelines or canals called reservoirs. **N)** In Santa Clara County, we import much of our water from northern California (Lake Shasta, Lake Oroville and Hetch Hetchy).

O) A lot of our water comes from underground. **P)** We pump it up in wells. **Q)** Underground water is replaced by percolation in a process called groundwater recharge. **R)** Much of our imported water is used to recharge our aqueducts.

S) As water moves around on earth, it can get dirty or polluted. **T)** So before we use it, we often need to treat it to make sure it is clean and safe. **U)** Water treatment plants do this through such processes as disinfection, clarification and filtration. **V)** In disinfection, a machine is used to kill any germs that might hurt us. **W)** Clarification uses chemicals to remove dirt from the water. **X)** Finally, in filtration, water runs through beds of sand and gravel to remove any remaining impurities.

Y) There are other problems besides water pollution. **Z)** Sometimes we get more water than we want at one time and flooding occurs. **AA)** At other times, we don't get enough precipitation for our water supply needs. **BB)** These dry spells are called oases. **CC)** If we can't get enough water above ground, we must use more groundwater, but if we pump too much water, subsidence can occur.

DD) In order to get the most benefit out of the water we have, we must use as much of it as possible. **EE)** By practicing conservation, our supplies will last much longer.

FF) Besides natural pollution, humans pollute water, too. **GG)** Some of this pollution occurs at specific sites, such as a factory where dirty water is released into a stream or bay. **HH)** This is an example of organic pollution.

II) Additional pollution is caused by water being contaminated as it runs over the ground on its way to a river or the ocean. **JJ)** When people dump such things as litter, oil, paint or pesticides on the ground, stormwater runoff can pick up these pollutants, causing nonpoint source pollution.

KK) In order to solve this kind of water quantity problem, we need to be aware of its causes and effects. **LL)** Then we must be careful about what we throw away and where we throw it. **MM)** If we all work together, we can stretch our supplies and keep our water pure and clean.

Rain To Drain—Water For The Santa Clara Valley Posttest

The following material describes the role of water in the Santa Clara Valley—its basic nature, sources of supply, treatment, use, conservation and quality. Read the material and see if you can identify the eight incorrect statements. When you find a sentence that is untrue, write the letter in front of the incorrect sentence on the back of this sheet of paper and then briefly explain why it is untrue.

A) Water is found in three forms, solid, liquid and vapor. **B)** Examples of these forms are: solid - ice, liquid—rain and vapor—hail. **C)** Water changes from one form to another as it moves through the water cycle. **D)** The cycle begins with precipitation when water falls to earth as rain, snow or hail. **E)** Once on the ground, it may run off into rivers, lakes and oceans. **F)** Or, it may percolate down into the ground to be used by plants or to collect in aquifers.

G) After using the water for growth, plants give some water back to the atmosphere in a process called transpiration. **H)** Other water goes back into the air from lakes and rivers by percolation. **I)** Once in the air, the cycle can start all over again.

J) People use lots of water. **K)** We use it to drink, bathe, grow our food, play in and manufacture products. **L)** Sometimes we have to import water from a distant place to where we want to use it. **M)** To do this, we use pipelines or canals called aqueducts. **N)** In Santa Clara County, we import much of our water from southern California (Lake Shasta, Lake Oroville and Hetch Hetchy).

O) A lot of our water comes from underground. **P)** We pump it up in wells. **Q)** Underground water is replaced by percolation in a process called subsidence. **R)** Much of our imported water is used to recharge our aquifers.

S) As water moves around on earth, it can get dirty or polluted. **T)** So before we use it, we often need to treat it to make sure it is clean and safe. **U)** Water treatment plants do this through such processes as disinfection, clarification and filtration. **V)** In disinfection, a safe chemical is used to kill any germs that might hurt us. **W)** Clarification uses chemicals to remove dirt from the water. **X)** Finally, in filtration, water runs through beds of cotton to remove any remaining impurities.

Y) There are other problems besides water pollution. **Z)** Sometimes we get more water than we want at one time and flooding occurs. **AA)** At other times, we don't get enough precipitation for our water supply needs. **BB)** These dry spells are called droughts. **CC)** If we can't get enough water above ground, we must use more groundwater, but if we pump too much water, percolation can occur.

DD) In order to get the most benefit out of the water we have, we must use it wisely. **EE)** By practicing coagulation, our supplies will last much longer.

FF) Besides natural pollution, humans pollute water, too. **GG)** Some of this pollution occurs at specific sites, such as a factory where dirty water is released into a stream or bay. **HH)** This is an example of point source pollution.

II) Additional pollution is caused by water being contaminated as it runs over the ground on its way to a river or the ocean. **JJ)** When people dump such things as litter, oil, paint or pesticides on the ground, stormwater runoff can pick up these pollutants, causing subpoint source pollution.

KK) In order to solve this kind of water quality problem, we need to be aware of its causes and effects. **LL)** Then we must be careful about what we throw away and where we throw it. **MM)** If we all work together, we can stretch our supplies and keep our water pure and clean.

Repro Answer Keys

The "Santa Clara Valley Hidden Water Names" puzzle repro is found on page 24 of this guide. The activity focuses on local geography with 31 names of local towns, cities and/or water facilities. Its use is included in the Bonus Activities of "Water in Use and Water Supply Problems" lesson, pages 9–10 of this guide.

The activity works especially well as an enjoyable spelling lesson on these sites. The answer key to the puzzle is as follows. To locate the first letter of the water names, use the coordinates provided.

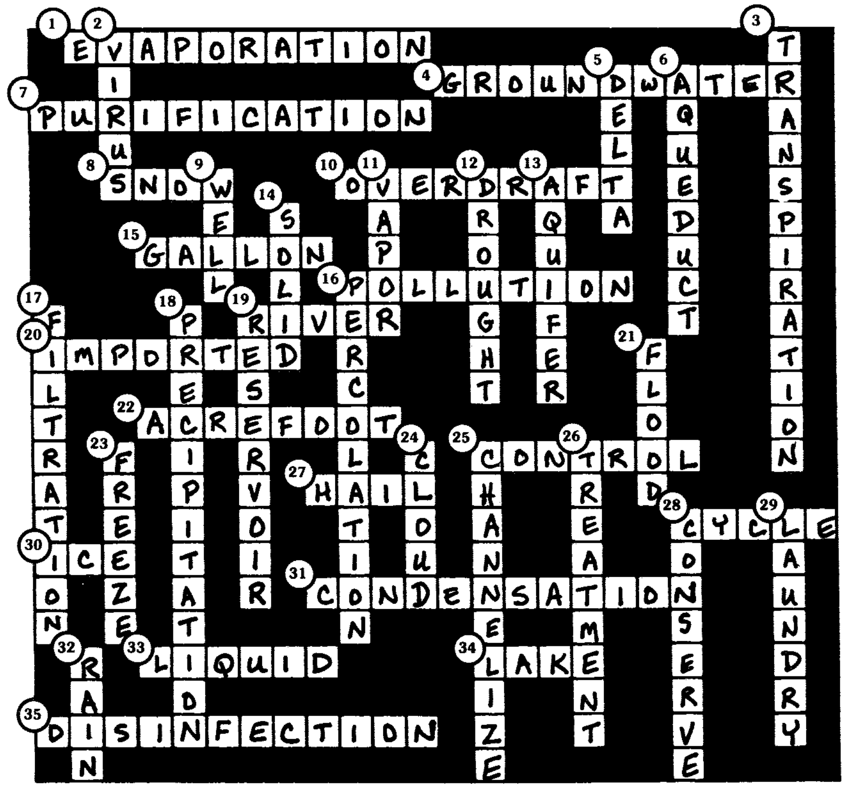
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1	O	D	E	L	T	A	M	E	N	D	O	T	A	S	A	N	J	O	A	Q	U	I	N
2	R		T	C	E	J	O	R	P	R	E	T	A	W	E	T	A	T	S				
3	B	M		L	L	E	B	P	M	A	C	A	L	I	F	O	R	N	I	A	M		
4	S	O		O	T	L	A	O	L	A	P	C	S				A				I		
5	E	U						M	O	R	G	A	N	H	I	L	L		U		L		
6	H	N			G				S	A	N	L	U	I	S		C	V			P	G	
7	C	T				I			G	M		E		N	E	D	A	M	L	A	I	U	
8	**V**	**A**	L	**L**	**E**	**Y**	L	**W**	**A**	**T**	**E**	**R**		**D**	**I**	**S**	**T**	**R**	**I**	**C**	**T**	A	
9	A	I		C	U	P	E	R	T	I	N	O	S	R	E	D	N	A			A	D	
10	S	N	Y	A	B	H	T	U	O	S		O	T	N	E	M	A	R	C	A	S	A	
11	O	V				I	O		S	Y	E	S	O	J	N	A	S					L	
12	N	I			N		Y	H	C	T	E	H	H	C	T	E	H					U	
13	A	E				N	O	T	G	N	I	X	E	L	A	V	Y	N	N	U	S	P	
14		W	K	E	E	R	C	S	N	E	Y	E	T	S	A	N	F	E	L	I	P	E	

ALMADEN Reservoir (T-7)
ANDERSON Reservoir (R-9)
CALERO Reservoir (L-4)
CALIFORNIA Aqueduct (K-3)
CAMPBELL (K-3)
CHESBRO Reservoir (A-7)
COYOTE Reservoir (G-14)
CUPERTINO (D-9)
DELTA-MENDOTA Canal (B-1)
GILROY (E-6)
GUADALUPE Reservoir (V-6)

HETCH-HETCHY Aqueduct (Q-12)
LEXINGTON Reservoir (N-13)
LOS GATOS (I-4)
MILPITAS (U-3)
MORGAN HILL (H-5)
MOUNTAIN VIEW (B-3)
PALO ALTO (K-4)
SACRAMENTO River (U-10)
SAN JOSE (Q-11)
SAN FELIPE Project (N-14)

SAN JOAQUIN River (N-1)
SAN LUIS Reservoir (I-6)
SAN MARTIN (M-4)
SANTA CLARA (Q-11)
SOUTH BAY Aqueduct (J-10)
STATE WATER PROJECT (S-2)
STEVENS CREEK Reservoir (N-14)
SUNNYVALE (U-13)
UVAS Reservoir (S-5)
VASONA Reservoir (A-8)

The "Water Crossword," a repro of which is supplied on page 25 of this guide, serves as an excellent mid-unit review of basic water vocabulary. Hence, it is suggested in the Bonus Activities of the "Water Conservation" lesson, found on page 11. If classtime does not accommodate its use, it can be assigned as a required or optional homework activity. In fact, parents might enjoy providing some assistance on this task. The answer key to the puzzle is provided here.



Pretest and Posttest Answer Keys

Provided below are the incorrect sentences in the unit pretest and posttest. The incorrect word or words are found in parentheses; the correct language is capitalized.

PRETEST ANSWER KEY

D) The cycle begins with (evaporation) **PRECIPITATION** when water falls to earth as rain, snow or hail.

G) After using the water for growth, plants give some water back to the atmosphere in a process called (chlorination) **TRANSPIRATION.**

M) To do this, we use pipelines or canals called (reservoirs) **AQUEDUCTS.**

R) Much of our imported water is used to recharge our (aqueducts) **AQUIFERS.**

V) In disinfection, a (machine) **SAFE CHEMICAL** is used to kill any germs that might hurt us.

BB) These dry spells are called (oases) **DROUGHTS.**

DD) In order to get the most benefit out of the water we have, we must use (as much of it as possible) **IT WISELY.**

HH) This is an example of (organic) **POINT SOURCE** pollution.

POSTTEST ANSWER KEY

B) Examples of these forms are: solid — ice, liquid — rain and vapor — (hail) **STEAM.**

H) Other water goes back into the air from lakes and rivers by (percolation) **EVAPORATION.**

N) In Santa Clara County, we import much of our water from (southern) **NORTHERN** California (Lake Shasta, Lake Oroville and Hetch Hetchy).

Q) Underground water is replaced by percolation in a process called (subsidence) **GROUNDWATER RECHARGE.**

X) Finally, in filtration, water runs through beds of (cotton) **SAND AND GRAVEL** to remove any remaining impurities.

CC) If we can't get enough water above ground, we must use more groundwater, but if we pump too much water, (percolation) **SUBSIDENCE** can occur.

EE) By practicing (coagulation) **CONSERVATION,** our supplies will last much longer.

JJ) When people dump such things as litter, oil, paint or pesticides on the ground, stormwater runoff can pick up these pollutants, causing (subpoint) **NONPOINT** source pollution.

Glossary

ACRE-FOOT — Amount of water it takes to cover one acre with one foot of water.

AQUEDUCT — Large pipeline or canal used to transport water.

AQUIFER — Large underground beds of sand and gravel which hold water.

BACTERIA — Very small organisms which often cause disease.

CHANNELIZE — Process of making a stream wider, deeper, straighter or smoother flowing so that it can carry more water.

CLARIFICATION — Second step of water purification in which chemicals are added to the water to remove most of the impurities which make the water cloudy

CLOUD — Visible mass of tiny water droplets, mixed with vapor, suspended in air.

CONDENSATION — Process in which water vapor cools into tiny droplets, which collect and form clouds.

CONSERVATION — Saving water instead of wasting it.

DELTA — Triangle-shaped area at the mouth of one or more rivers.

DISINFECTION — Process in which chemicals are added to water to kill germs.

DROUGHT — Period of time in which little or no rain falls.

EVAPORATION — Process in which water is warmed by the sun, turns into a vapor and rises into the air.

FACTORY — Manufacturing plant which can be a source of point source pollution.

FILTRATION — Third step of water purification in which water flows through layers of charcoal, sand and gravel to remove tiny particles.

FLOOD — An overflowing of water onto land that is normally dry.

FLOOD CONTROL — Reducing the potential for flood damage by channelizing streams and building flood plains.

FLOOD PLAIN — Area next to a stream which can be flooded during storms without causing damage.

FREEZE — Turning water from a liquid to a solid.

GALLON — Volume of water equal to four quarts. 325,829 gallons = one acre foot.

GROUNDWATER — Rain or surface water which has seeped down through the soil to aquifers.

GROUNDWATER RECHARGE — Process of using percolation ponds to replace water taken from an aquifer.

HAIL — Precipitation in the form of small, solid balls of ice and hard snow.

HEAVY METALS — Metals, such as lead, zinc, copper and chromium, which can harm fish life when they become dissolved in water.

ICE — Solid form of water.

IMPORTED WATER — Water brought from one area to another.

IMPURITIES — Things that are dirty and unclean.

INORGANIC — Involving non-living matter, like minerals and salts.

LAKE — Fairly large inland body of water.

LAUNDRY — Place where dirty clothes are washed.

LIQUID — Substance which can flow or be poured.

NONPOINT SOURCE POLLUTION — Water pollution caused by a variety of sources which flows into a receiving water through storm water runoff and storm drains.

ORGANIC — Living or dead plant or animal matter.

OVERDRAFT — To take out more groundwater than is replaced.

PERCOLATION — Process in which water seeps down into the earth.

POINT SOURCE POLLUTION — Pollution coming from a specific point, such as a factory or refinery.

POLLUTION — Condition of dirty or unusable air, water or land; as organic or inorganic matter in wastewater.

PRECIPITATION — Rain, snow or hail which falls from clouds.

PRIMARY TREATMENT — First stage of wastewater treatment which removes solids that settle to the bottom or float to the top of the wastewater.

PURIFICATION — Process of taking impurities out of water.

RAIN — Precipitation in the form of water.

RESERVOIR — Man-made lake used for storing water.

RIVER — Flowing body of water.

RUNOFF — Rainfall and other water which runs off into streams, lakes and San Francisco Bay.

SECONDARY TREATMENT — Second stage of wastewater treatment which uses oxygen to encourage growth of bacteria to break down impurities in the wastewater.

SEWAGE — Solid and liquid waste material from homes, stores and industries that flows into underground sewer pipes.

SNOW — Precipitation in the form of crystals of frozen water.

SOLVENT — Liquid used to remove stains by dissolving them.

STORM DRAIN SYSTEM — Wastewater system designed to carry off storm water runoff but not sewage from homes and industry.

STORM WATER — Water from rains which runs off the land, carrying pollutants into a body of water.

SUBSIDENCE — Sinking ground because too much water has been removed from underneath.

TERTIARY TREATMENT — Third stage of wastewater treatment which uses advanced equipment and chemicals to get rid of difficult pollutants.

TRANSPIRATION — Process of plants giving off water vapor from their leaves.

VAPOR — Water in the form of a gas.

VIRUS — Disease-causing germs.

WASTEWATER — Water that carries people's pollutants; sewage.

WASTEWATER TREATMENT — Process used to clean wastewater so that it can be discharged into a receiving water.

WATER CYCLE — Process of water movement including evaporation, transpiration, condensation, precipitation and percolation.

WATER TREATMENT PLANT — Plant used to prepare water for drinking.

WELL — Hole drilled in the ground to get water.

LESSON NOTES

NAME________________________

SANTA CLARA VALLEY HIDDEN WATER NAMES

Hidden in the puzzle below are 31 water names from in and around the Santa Clara Valley. They include natural and artificial reservoirs and waterways, many of which are part of the Valley Water District's supply system, along with some important Valley towns and cities.

First study the list of names provided, then try to locate them in the puzzle. Except for the STATE WATER PROJECT, only the proper part of the name has been used. For example, only ALMADEN is used, not Reservoir. Also, no spaces are provided in two-word names. The names may be spelled out forwards, backwards or on the diagonal. When you have found a name, circle it.

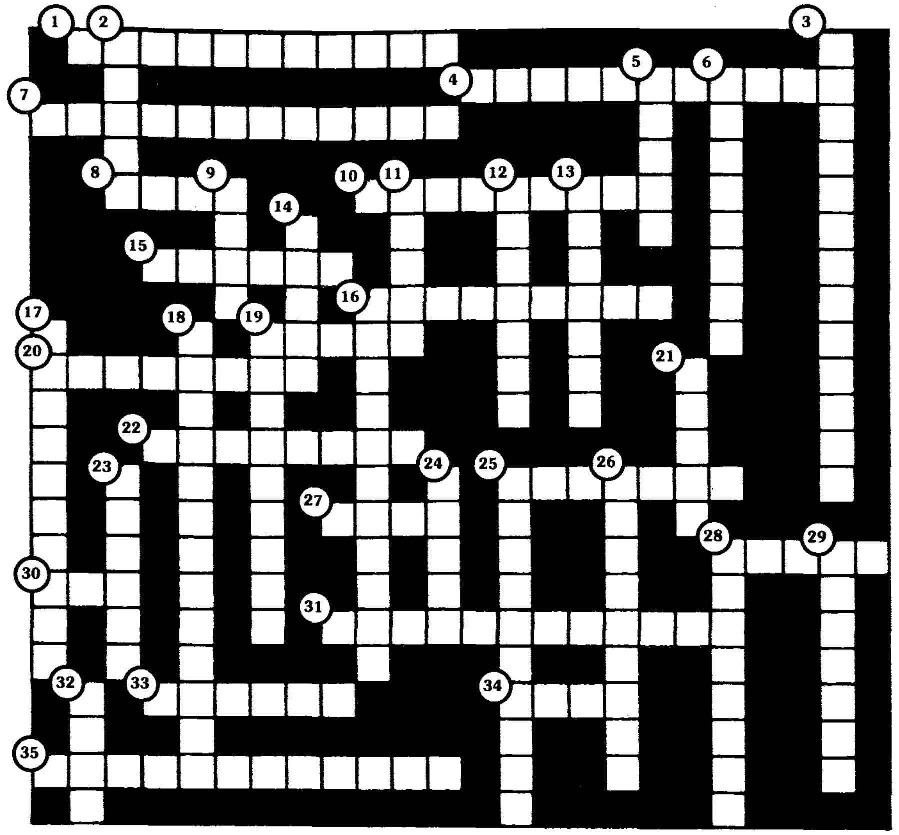
ALMADEN Reservoir
ANDERSON Reservoir
CALERO Reservoir
CALIFORNIA Aqueduct
CAMPBELL
CHESBRO Reservoir
COYOTE Reservoir
CUPERTINO
DELTA-MENDOTA Canal
GILROY
GUADALUPE Reservoir
HETCH-HETCHY Aqueduct
LEXINGTON Reservoir
LOS GATOS
MILPITAS
MORGAN HILL
MOUNTAIN VIEW
PALO ALTO
SACRAMENTO River
SAN JOSE
SAN FELIPE Project
SAN JOAQUIN River
SAN LUIS Reservoir
SAN MARTIN
SANTA CLARA
SOUTH BAY Aqueduct
STATE WATER PROJECT
STEVENS CREEK Reservoir
SUNNYVALE
UVAS Reservoir
VASONA Reservoir

O	D	E	L	T	A	M	E	N	D	O	T	A	S	A	N	J	O	A	Q	U	I	N
R	A	T	C	E	J	O	R	P	R	E	T	A	W	E	T	A	T	S	B	O	S	M
B	M	C	L	L	E	B	P	M	A	C	A	L	I	F	O	R	N	I	A	M	X	U
S	O	T	O	T	L	A	O	L	A	P	C	S	D	I	I	A	E	J	F	I	B	P
E	U	G	V	X	E	H	M	O	R	G	A	N	H	I	L	L	V	U	O	L	F	V
H	N	N	E	G	L	H	K	S	A	N	L	U	I	S	G	C	V	K	J	P	G	W
C	T	L	S	R	I	W	J	G	M	Y	E	M	N	E	D	A	M	L	A	I	U	G
V	**A**	**L**	**L**	**E**	**Y**	L	**W**	**A**	**T**	**E**	**R**	Z	**D**	**I**	**S**	**T**	**R**	**I**	**C**	**T**	A	A
A	I	Y	C	U	P	E	R	T	I	N	O	S	R	E	D	N	A	N	M	A	D	L
S	N	Y	A	B	H	T	U	O	S	C	O	T	N	E	M	A	R	C	A	S	A	Q
O	V	P	I	B	I	O	K	S	Y	E	S	O	J	N	A	S	C	B	J	O	L	S
N	I	J	F	N	H	Y	H	C	T	E	H	H	C	T	E	H	R	W	Z	E	U	D
A	E	T	Q	D	N	O	T	G	N	I	X	E	L	A	Y	Y	N	N	U	S	P	K
R	W	K	E	E	R	C	S	N	E	Y	E	T	S	A	N	F	E	L	I	P	E	N

NAME________________________

WATER CROSSWORD

This puzzle features 38 water words used in this unit. See how well you've learned the vocabulary by studying the clues and writing the correct words in the spaces provided. If you have a problem, check your glossary.



ACROSS

1. Water is warmed by the sun, turns into a vapor and rises into the air.
4. Water which has seeped into aquifers.
7. Taking impurities out of water.
8. Crystals of frozen water.
10. To take out more groundwater than is replaced naturally.
15. Four quarts.
16. Something that causes water to become dirty.
19. Flowing body of water.
20. Water brought from one area to another.
22. 325,829 gallons, or enough water to cover one acre one foot deep. (2 words)
25. Reducing flood damage by channelizing streams and building flood plains; FLOOD ______________.
27. Small, solid balls of ice and hard snow.
28. Evaporation, transpiration, condensation, precipitation and percolation; WATER ______________.
30. Solid form of water.
31. Water vapor cools into tiny droplets, which collect and form clouds.
33. Substance which can flow or be poured.
34. Fairly large inland body of water.
35. Adding chemicals to water to kill germs.

DOWN

2. Disease-causing germs.
3. Plants giving off water vapor from their leaves.
5. Triangle-shaped area at the mouth of one or more rivers.
6. Large pipeline or canal used to transport water.
9. Hole drilled in the ground to get water.
11. Water in the form of gas.
12. Period of little or no rain.
13. Large underground beds of sand and gravel which hold water.
14. Not a liquid or a gas.
16. Water seeping down into the earth.
17. Water flowing through layers of charcoal and sand to remove tiny particles.
18. Rain, snow or hail which falls from clouds.
19. Manmade lake used for storing water.
21. Area which can be flooded during storms without causing damage; ______________ PLAIN.
23. Turning water from a liquid to a solid.
24. Visible mass of tiny water droplets, mixed with vapor, suspended in air.
25. Making a stream wider, deeper, straighter or smoother flowing.
26. Plant used to prepare water for drinking.
28. To save water instead of wasting it.
29. Place where dirty clothes are washed.
32. Precipitation in the form of water.

Thanks, Educator

As you use this material, please accept the appreciation of the Santa Clara Valley Water District and the Santa Clara Valley Nonpoint Source Pollution Control Program. By integrating this information about water, conservation and pollution into your curriculum, you are helping students gain an appreciation, awareness and knowledge of our most precious natural resource.

Only with this knowledge and appreciation can people make intelligent use of and informed decisions regarding our water. Prolonged droughts over the past 20 years, coupled with persistent population growth, underscore the need for more student knowledge. In particular, students need information regarding:

- the wise use of water which has all too often been in scarce supply in recent years, and
- the proper disposal of wastes that are washing into south San Francisco Bay in ever-increasing quantities.

About the Santa Clara Valley Water District

The Santa Clara Valley Water District is a public water management agency which builds and operates local water conservation and treatment facilities, imports water from outside the area and conducts all flood control programs in the county. It is governed by a seven-member board of directors, five of whom are elected by district and two appointed by county supervisors. The water district is not a water retailer; this is the task of investor-owned and city-owned systems. These include the cities of Cupertino, Gilroy, Milpitas, Morgan Hill, Mountain View, Palo Alto, San Jose and Santa Clara, as well as San Jose Water Co., California Water Service Co., Great Oaks Water Co., and several small retail water agencies.

The water district's predecessor agency, the Santa Clara Valley Water Conservation District, was formed in 1929. Impetus for formation was the dwindling supply of underground water, caused by low annual rainfall and the growing number of farmers in the Valley. Voters approved formation by a vote of nine-to-one, and the new district promptly set about building conservation dams and groundwater recharge (percolation) facilities. The effort helped to restore the underground water supply for the central and north valley area.

Groundwater replenishment also helped to curtail land subsidence. Engineers in 1933 had determined that a 200-square-mile area — bounded by Redwood City, Alum Rock, Coyote and Los Gatos — was sinking in elevation. By 1969, the land surface elevation had dropped by 10 feet in Alviso, and as much as 13 feet in some areas of San Jose.

Formation of the district solved most of the Valley's other water supply problems, until the population boom began in the 1940s. The new growth added to the problems of low water tables, dry wells, continued subsidence and the danger of underground salt water pushing inland from the Bay and contaminating well fields. To counter these dangers, the district built several additional dams on local streams, and made plans for importing water into the Valley via the federal San Felipe Project.

While all this was happening, in the early 1950s, the Santa Clara County Flood Control and Water District was formed. This new agency was empowered to solve flood control and water supply problems on a county-wide basis. In the early 1960s, the agency contracted with the state of California to import water through the South Bay Aqueduct of the State Water Project.

In 1968, the two districts consolidated to create the Santa Clara Valley Water District — a county-wide water management agency. Today, district activities include conservation, importation and reclamation of water, flood control, coordination of other water-related programs and soliciting and listening to public comment. The water district also serves as the lead agency for the Santa Clara Valley Nonpoint Source Pollution Control Program, described later in this section.

Flood Control

Although the Santa Clara Valley is semi-arid and gets only 14 inches of rain in a typical year, there are times when a great deal of the rainfall comes all at one time. In a big storm, it is not unusual to see flood water racing down our normally dry streams. Sometimes these torrents spill into homes, businesses and farms.

A large portion of the district's efforts go into protecting communities from flooding. Since 1951, the district has been building flood channels, trying to convince local cities to keep development away from creeks, and creating floodplains where waters can spill without causing much damage. The district prefers not to build concrete-lined channels, but these are sometimes unavoidable if buildings are located too close to a creek.

Aesthetically, the district prefers other types of streambank linings to concrete, such as rock-filled wire baskets known as gabions, rock-lining and low floodwalls, as well as modified flood plains.

The original intent of local reservoirs was to store our water supplies, so there was not additional capacity built in to hold flood waters. However, if a major storm hits while the reservoirs are not full, they definitely provide temporary flood protection.

It should also be noted that creeks swollen with flood waters may be inviting places to play, but people should be aware that they are extremely dangerous for both children and adults.

Water Supply

RAINFALL — The most obvious source of our water supply is local rainfall — a constant reminder of the renewable nature of this resource. Some of this water serves as a direct supply to our gardens and homes; some seeps naturally deep into the earth where it can be retrieved later from wells. Rain which falls in the mountains and hills around the Valley is captured in 10 reservoirs: Almaden, Anderson, Calero, Chesbro, Coyote, Guadalupe, Lexington, Stevens Creek, Uvas and Vasona. The water district sometimes employs cloud seeding to maximize rainfall from local storms. Although such weather modification cannot cause rain, it can slightly increase the rainfall yield from a given storm.

GROUNDWATER — About one-half of all the water we use in our valley comes from beneath the ground. Groundwater is in water-bearing strata called aquifers, and the water is pumped to the surface through wells by local water departments, farmers, industries, water companies and others.

While some small amounts of water are piped from the 10 local reservoirs to treatment plants, almost all water captured behind the dams is percolated (trickled down) into underground storage areas (aquifers) for later removal. Groundwater seeps into the aquifers through surface gravel and sand deposits that extend deep into the ground. Some of these percolation sites are found in stream beds; others are in off-stream groundwater recharge (percolation) ponds. Geologists discover these areas and then the district, if it can, establishes a groundwater recharge site. Very few of these areas exist, because most of the valley floor is covered by thick deposits of clay.

IMPORTED WATER — Three different projects carry imported water into the Santa Clara Valley.

State Water Project — California

One is the South Bay Aqueduct, which, since 1965, has brought us water from northern and eastern California. This is part of the State Water Project, which also supplies water to the San Joaquin Valley and Southern California. Approximately 100,000 acre-feet of water comes to us from this source — enough to cover 1,000 football fields to a depth approximately equal to the height of the Empire State Building. About 80,000 acre feet of this water is filtered and disinfected at the district's three treatment plants. The remaining water is placed into creeks and percolation ponds, where it recharges drinking water aquifers.

Hetch Hetchy Project — San Francisco

A second source of imported water to our valley is the Hetch Hetchy system, owned by the City of San Francisco. About 65,000 acre-feet of water per year is piped from Hetch Hetchy Reservoir in the Sierras to several cities in the north Santa Clara Valley.

San Felipe Project — Federal

The Valley's third and newest source of imported water is the San Felipe Project, first looked into as a supplemental supply in the 1940s. Completed by the U.S. Bureau of Reclamation in 1987, the project is operated by the district, and brings water to Santa Clara Valley. This water originally was released from Shasta Dam on the Upper Sacramento River. Pumps and aqueducts transfer the water from the Sacramento-San Joaquin Delta into San Luis Reservoir. It is then pumped into tunnels and pipelines that carry it to the district's own distribution system. San Felipe ultimately will provide us with up to 152,000 acre-feet per year of water for treatment and recharge.

WATER TREATMENT — The district operates three treatment plants that filter and disinfect water from the State Water Project and San Felipe Project (and sometimes small amounts from district reservoirs). The three plants are Rinconada in Los Gatos; Penitencia in east San Jose; and Santa Teresa in Almaden Valley. Together, these plants treat up to 220,000 gallons per day.

The treatment process is surprisingly simple, yet it is extremely important to public health. First, bacteria are killed through disinfection. The next step is to remove heavy and suspended solids. Finally, the water is "polished" by letting it filter through sand and gravel. Another small dose of disinfectant chemical is added when the water has been fully treated, to keep the water free of bacteria. Finally, the water is ready to be sent to private water companies and city water departments, which in turn deliver it to consumers.

RECLAIMED WATER — The Santa Clara Valley Water District and the City of Gilroy jointly operate a wastewater reclamation facility located at the Gilroy Regional Sewage Treatment Plant. Water from the plant receives a high level of treatment and is distributed for agricultural use, reducing some of the demand for water which would otherwise come from one of the sources mentioned above.

WATER SAVINGS: A KEY TO OUR FUTURE — Although the district uses a variety of water supply sources, a significant portion of future supply must be derived from water savings efforts on the part of all user groups. To this end, an aggressive, permanent water conservation education program is in place and is an important component in district planning and operation. Your assistance in this effort is essential, because the students of today have the most to gain — or lose — by its success or failure.

WATER QUALITY — Protecting water quality is a major concern of the water district. While the district does not have enforcement powers, it does take a leadership role in water quality protection. Among actions taken to further water quality is taking a lead role in carrying out the Santa Clara Valley Nonpoint Source Pollution Control Project, discussed in greater detail below.

It also includes helping cities and the county to enforce hazardous materials storage ordinances, sealing abandoned wells that could serve as conduits for leaking chemical or fuel tanks, managing fuel tank clean-up programs, providing technical assistance to other agencies and maintaining the quality of drinking water produced at the three district treatment plants.

About the Santa Clara Valley Nonpoint Source Pollution Control Program

WHAT IS IT? — Even though most people in the Santa Clara Valley live many miles from San Francisco Bay, things they do may well be polluting Bay waters without them even knowing it. Many of the products we use in our homes — such as motor oil, paint products, cleaning chemicals, garden poisons and fertilizers — can be washed into the Bay by stormwater runoff. These substances harm wildlife and fisheries and ruin recreation areas.

Because these materials come from so many sources, they are collectively known as nonpoint source pollution. The basic groups from which pollutants come include:

- Oil and grease from automotive leaks and spills or improper disposal of used oil and automotive products into storm drains.
- Metals found in vehicle exhaust, weathered paint, metal plating, tires and motor oil.
- Pesticides, herbicides and fertilizers from lawns, gardens, farms and improper disposal.
- Soil erosion from lawns, hillsides and construction activities.
- Biological contaminants from litter, organic matter and animal wastes.

Nonpoint source pollution originates on streets, in parking lots, from yards — even off of vacant land. And many chemicals discarded in early summer are still capable of polluting the Bay months later with the first storms of fall or winter.

HISTORY — With increasing population, the problem has grown to serious proportions in recent years, particularly in South San Francisco Bay, where pollution tends to become more concentrated than in other parts of the Bay because of limited water circulation.

Making people aware that problems arise from carelessly disposing of household chemicals, used motor oil and other pollutants is one reason that the Santa Clara Valley Nonpoint Source Pollution Control Program was established. Formed in 1987 and approved by the Environmental Protection Agency in 1990, the program is a joint effort of communities within the Santa Clara Valley.

Members of the program are the Santa Clara Valley Water District, Santa Clara County and 13 cities in the South Bay — Campbell, Cupertino, Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte Sereno, Mountain View, Palo Alto, San Jose, Santa Clara, Saratoga and Sunnyvale.

PROGRAM OBJECTIVES — Their objective, through a variety of programs, is to reduce the flow of nonpoint source pollutants without creating a new bureaucracy or spending billions on storm drain treatment facilities used only a few weeks out of the year.

Studies have begun to identify the nature and types of pollutants carried into the Bay by stormwater. The program also has begun monitoring storm drain discharges to better identify some of the multitude of possible sources, as well. Based on the study findings, the program has taken several steps to better control and reduce pollutant runoff wherever possible.

Among other things, the member agencies are increasing efforts to clean streets, control litter, collect solid waste, and even physically clean actual catch basins entering storm drains. They are also working for better control of pollutants that could get into stormwater runoff from industries, transport services and construction sites.

PUBLIC AWARENESS — In addition to these specific actions, the program participants also are devoting time and money to educating students and the general public to the problems brought about by nonpoint source pollution in the South Bay. In addition to the information in this teacher's guide and the accompanying **Rain to Drain** student material, several other activities aimed at the adult population are underway, including curb marking reminders at catch basins, public service advertising and presentations at community gatherings.

The student book provides additional information on the subject of nonpoint source pollution, and we commend pages 19-23 to your attention if, as with most people, this is a new subject to you.